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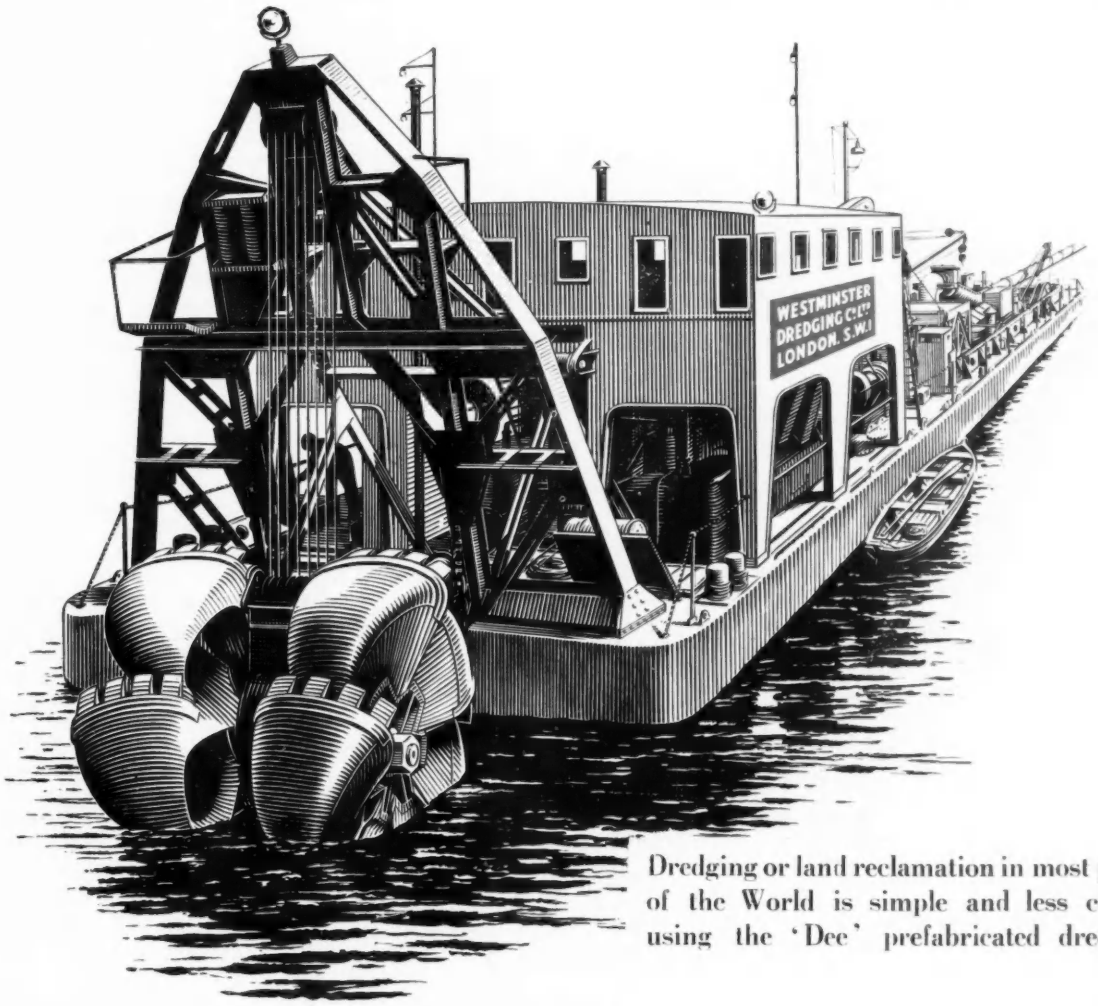

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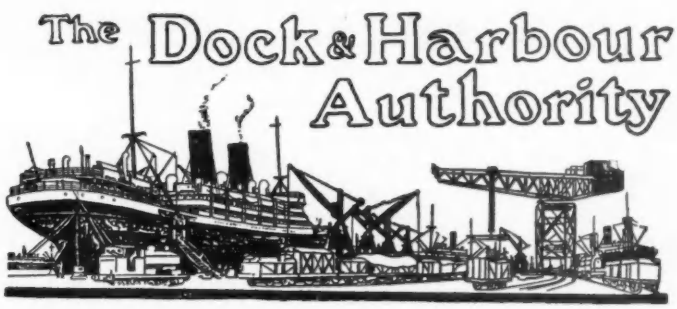

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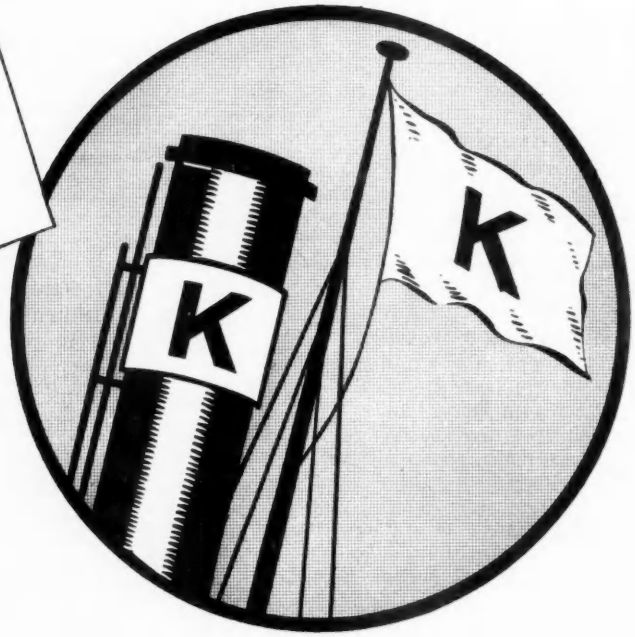

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The Dock and Harbour Authority

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Editorial Comments

PORT ADMINISTRATION AND PORT KEMBLA

The control and administration of ports is a subject of particular interest in the United Kingdom at the present time, and from an Address by Mr. G. A. Whitton, which forms the basis of the leading article in this issue, readers will be able to acquire some insight into Australian methods of port control, and of the administrative system and duties of the Maritime Services Board of New South Wales. The author of the article also makes some pertinent observations on port finances generally, and in connection with financial costs, significantly remarks that the working of some of the oldest wharves in Sydney compares more than favourably with some of those more recently built and equipped. Unfortunately, poor results in the handling of general cargo are by no means confined to Australia, and it seems that a really satisfactory remedy is still obscure.

Port Kembla, to which special reference was made by Mr. Whitton, originated as a shipping place for the export of coal which was discovered in the Illawarra district in 1797, but was not worked commercially until sixty years later. Subsequently, early in the present century, several other industries in addition to coal mining were started. These include iron smelting and refining, steel manufacture, the production of structural steel, and the manufacture of fertilisers, fire bricks, etc. To meet the needs of these heavy industries, a scheme of improvements was planned in 1938, when the port was still administered by the Department of Public Works. Some of these improvements have been executed, and details were given in an article which appeared in the April 1939 issue of this Journal. The most important items were the taking over and reconstruction and re-equipment of several privately operated jetties for the handling of coal and coke exports, and the import of ores, together with the construction of No. 3 jetty, which is used for general cargo handling.

Mr. Whitton also gives a description of the coal handling plant which was adopted for the re-equipment of No. 1 jetty, and compares this plant with the one now being constructed at the Port of Baltimore, U.S.A. In this respect, we are fortunate in also being able to publish, this month, an article dealing with the latter plant, which is to be operated by the Baltimore and Ohio Railway Company, and is expected to be completed early this year.

As to future developments at Kembla, it seems that the export of coal has shown a decline, the bulk of the present export trade now consisting of the finished products of the various industries operating in the vicinity. Imports consist almost wholly of the raw materials required by those industries, such as ironstone and other ores of various types, limestone, phosphate rock, etc. Improvement at the port, apart from any increase in harbour accommodation, which may be required, is likely, therefore, to be concentrated upon bulk handling equipment, and in the second instalment of Mr. Whitton's paper, which will appear next month, a survey is given of modern trends in the design of vessels specially built for bulk carrying and unloading, together with short descriptions of shore-based bulk handling appliances at various world ports.

BULK HANDLING PLANT AT THE PORT OF BALTIMORE

At the Port of Baltimore, Maryland, U.S.A., the belt type of handling conveyor has been developed to an advanced degree for the shipment of coal, and the Baltimore and Ohio Railway brought into use in 1918 what was then considered a remarkable installation. As mentioned in our previous comment, we are including in this issue an article by Mr. Grupp, an American contributor, giving details of a new pier and equipment in which the belt conveyor system figures prominently.

The geographical position of Baltimore, in relation to the industrial heart of the United States and the key steel manufacturing plants of the country, is particularly favourable. Moreover, the considerable advantage of low railway freight rates enjoyed by Baltimore, compared with those imposed on competing sea ports, places that city in a remarkably privileged position to secure a great share of the transhipment of future supplies of imported foreign ores.

Mr. Grupp gives some interesting information as to the sources of origin of these raw materials for the United States, and makes the significant remark that Labrador iron ore will flow to the steel centres of the Lake Erie area, via Baltimore, until the St. Lawrence Seaway is constructed.

This St. Lawrence scheme has been the cause of much controversy in the United States for many years past, and recently has been the subject of articles and comments in this Journal. It is probable that further news concerning the project will be forthcoming in the near future.

Readers concerned with bulk handling equipment will be interested in the technical description of the new plant being erected at Baltimore. A particular feature of the installation is its proximity to the Company's export coal pier, whereby a large number of empty railway waggons are made available for rapid loading and assembly into ore trains. Unloaded ore vessels also can easily be transferred to the coal berths for export cargoes.

BALTIMORE PORT AUTHORITY PROPOSALS

Apart from the important exports of coal and imports of iron ore at the Port of Baltimore, there are also a large number of piers and wharves owned by private individuals, industrial companies, the railroads, and the city of Baltimore, which deal with a great variety of traffic. These terminals are becoming inadequate to cope with the increasing volume of trade, and an extensive development and improvement scheme is being considered by private and public interests, which may have far reaching results.

Editorial Comments—continued

One solution to the problem has been suggested by the Steamship Trade Association, who advocate the establishment of a Port Authority to administer the affairs of the Port. A survey of the port and its needs was recently made by Messrs. Knappen, Tippetts & Abbett, Consulting Engineers, New York, and the Association agreed with their report which recommended, *inter alia*, that the marginal streets and highways serving the waterfront should be improved, to provide better vehicular access to the piers, but suggested that the schemes for the modernization and expansion of port facilities should be left to the proposed Port Commission.

The Association agreed that uniformity and equality should be established in respect to certain disimilarities in regard to docking charges for vesels, handling charges for cargoes moved by rail, and other anomalous and preferential arrangements in respect to free time for lorry and rail cargoes, storage during transit, and so on. They also felt that continued efforts to protect the favourable rail freight differentials enjoyed by Baltimore could best be effected in the future by unified port undertaking. These rail rate differentials were established some sixty-five years ago, and are most important, as Baltimore has lower railroad freight rates on export and import traffic moving to and from the interior of the country than New York, Boston or Philadelphia.

The composition of the Port Commission recommended by the Association includes one representative of the State, one from the City, and seven others from local interests.

CRANES, SHIP'S DERRICKS AND QUAY LAY-OUT

The article upon Quay Layout by Mr. Herman Jansson, which appeared in the January 1950 issue, has aroused interest in many quarters, and some of the correspondence received has already been published, and three further letters upon the subject will be found in this issue.

Mr. Rode, in his long communication, refers to three main types of vessels using the Port of Copenhagen, each necessitating differently planned quays and cargo handling equipment. He also mentions the attention which is now being directed towards building vessels with side ports or with special cranes. Readers will remember that, several times lately, these matters have been alluded to by other contributors.

Fixed jib cranes are mentioned by Mr. Osgood in his letter, and, of course, cranes working with a fixed radius are quite normal for many classes of bulk cargoes in certain situations. For example, for loading into railway wagons or the hoppers of belt conveyor systems, cranes are more serviceable than ship's derricks. On the other hand, the modern luffing ship's derricks and winches are claimed to be more efficient than fixed jib quay cranes for handling general cargo involving assembling and sorting on the quay. This would no doubt be due, in large measure, to the luffing possibilities of the derricks, thus giving a greater area of deposit.

The modern level luffing quay crane can achieve all its motions as rapidly as the fixed jib crane can perform its restricted movements, and the much greater reach of the luffing crane still further increases the area upon which cargo can be deposited. This is perhaps one of the chief assets of the modern quay crane, and, in any trials of general efficiency, it would be unfair to disregard it.

We think that the crucial test of the efficiency of the quay crane lies not so much in the amount of cargo it can raise from a ship's hold in a given time, but in the extent to which it can assist in other ways in the dispersal of cargo from the quay side, as, unless speedy dispersal is effected, congestion can easily stultify any gain in speed of derrick or crane.

In this respect, the greater reach of a quay crane makes possible the employment of transit sheds of two or more storeys, upon the verandahs of which cargo can be landed for dispersal or picked up for loading into ships, an operation which is beyond the capabilities of ship's derricks without some form of "Burtoning" which, in any case, is limited in its application. Moreover, the quay crane by its outreach enables a much wider quay or apron to be used, which helps the efficient operation of mobile trucks and other cargo handling appliances.

Notwithstanding the many good features of the quay crane, the high mechanical and operational efficiency of modern ship's derricks and winches must be conceded. In the end, however, consideration of the problem of transhipment of cargo will be governed by local conditions and requirements, and in many cases the two types of lifting appliance will be best treated as complementary and not competitive. Nevertheless, it would be helpful to have some information based on comparative tests as has been suggested in the letter by "Consulting Engineer," and we hope readers who have results of this description will forward them to us for publication.

PORT FACILITIES AT NEW YORK

It is both helpful and instructive to compare the different ways in which the same objects are achieved in various ports of the world, and readers will be especially interested in the article, reproduced on another page, which has been kindly contributed by Mr. Austin J. Tobin, Executive Director of the Port of New York Authority.

There have been many aspects of the Port of New York, which may have puzzled those who have not had the opportunity of visiting and examining, at first hand, that port's facilities, and Mr. Tobin throws much light upon questions and practices which have hitherto been obscure. The extreme difficulties with which the Port Authority contends will be duly appreciated when it is realised that it administers only some ten per cent. of the piers, quays, transit sheds and other port facilities, having no jurisdiction whatever over the remainder, which are owned by the City of New York, by shipping and railway companies, and by private dock concerns. Also there appears to be little co-operation in the formulation of improvement schemes designed to benefit the port as a whole.

Mr. Tobin draws attention to the serious internal and inter-port competitive factor induced by these conditions, and points out that the preferential rates afforded by facilities owned by railway and shipping competitors, are detrimental to the Port of New York Authority which is required to operate on a self-supporting basis. Some such conditions, of course, obtained in London before the formation of the Port of London Authority, as well as in other British Ports.

In some ways, physical conditions in the Port of New York are detrimental, notably the lack of land, and the consequent need to develop the finger pier system on the New York side of the harbour in order to obtain the maximum number of berths on the limited water frontage. Lack of space also makes it difficult to cater for the road transport which is being used to an increasing extent. Further, the majority of the depots or terminals of the rail-roads serving the port are on the opposite side of the harbour, so that an extensive lighterage service had to be developed. This, however, is considered, to some extent, to be a useful factor in aiding the quick turn-round of shipping, as it permits simultaneous loading and unloading of vessels from the quay and overside.

Readers who know British ports will see certain points of similarity between them and New York, and in particular between London and New York. In respect to privately owned wharves, however, the Port of London Authority owns and administers, with one insignificant exception, the whole of the various dock systems. It does not own the quays, wharves and warehouses on both sides of the river, but has the power of veto over extensions and alterations to them, and over new wharves which may be proposed for handling goods in competition with the Authority. The trade of these wharves is very great, representing a considerable percentage of the total trade of the port, but what is of the utmost importance, is the power given to the Port of London Authority to levy a tax, called a Port Rate, on all goods entering the port, whether they use the Authority's docks or not.

With regard to stevedoring, mechanisation and dock labour problems generally, conditions in New York appear to be somewhat similar to those in this country before the advent of decasualisation, and the institution of the National Dock Labour Board. It appears to us that 42,000 dockers, in New York alone, competing for 25,000 jobs, is an intolerable situation, creating intense dissatisfaction and unrest, and liable to have far reaching results. The problem surely is deserving of the earliest attention upon a national basis.

Port Administration in New South Wales

With Particular Reference to Port Kembla

By G. A. WHITTON
Vice-President, The Maritime Services Board of N.S.W.*

IN the first instalment of this paper, which owing to space restrictions has been divided into two parts, Mr. Whitton gives a brief general review of port administration by the Maritime Services Board of New South Wales, a short history of the development of Port Kembla and possible future expansion of facilities at the port, together with some references to the interrelation of the port and shipping with the heavy industries located in the district.

The second part of the paper gives some general observations regarding sea transport and cargo handling as related to heavy industries, which are made from the point of view of shipping and port administration and are not intended to be technical in any way.

In his introductory remarks, the speaker said it might not be out of place to refer to the necessity of giving very full and careful consideration to the requirements of the administrative and operative side of port control as one should not be solely guided by the engineering side when planning ports or improvements to ports.

SYSTEMS OF PORT CONTROL

There is no standard organisation for port administration throughout the world, but broadly speaking, the forms of port control can be divided into four comprehensive groups.

Firstly, there are the self-governing or trust ports, which are controlled and operated under the direction of users of the port and other interested organisations such as local government bodies who are represented by elected or nominated members of a governing Board or Harbour Trust. Examples of this nature are seen in London, Liverpool, Melbourne and ports in New Zealand. Such ports are usually financed by public subscriptions and loans. The second group comprises municipally owned ports such as Bristol in the United Kingdom, and certain American and European ports. These are usually governed by Committees or Boards of members drawn from the Municipal Council and the finances for port administration can be backed by the resources of the city itself. Until recently the third group comprised the privately owned ports, sometimes the ownership being vested in a single person as in the case of some few of the smaller harbours in Great Britain, but more usually the owners were the British Railway Companies. The Manchester Ship Canal Company owns and operates the Manchester Ship Canal and the Port of Manchester. With the passing of the Transport Act, 1949, in England all of the railway-owned ports in the United Kingdom were nationalised and brought under the control of the British Transport Commission.

In the fourth group, we find the most usual type of administration where the ports are owned by the Government and are administered by Commissioners or Boards appointed by the Government. It is this type of administration in this State and in South Australia. We find also that Canada, South Africa and certain European countries use this form of port administration, while, as mentioned earlier, Great Britain has recently taken steps to organise the majority of British ports and inland waterways under the control of a central Government Commission. Important characteristics of State operated ports are the extent of the financial resources which may be drawn upon in the general interest and the opportunity for planning and development on a national basis.

MARITIME SERVICES BOARD OF N.S.W.

The Maritime Services Board of N.S.W. is the administrative and navigation authority for all the ports and harbour of this State and was brought into existence on the 1st February, 1936, under the provisions of the Maritime Services Act. However, the Board is not an organisation of recent growth because, as the port and navigation authority of the State, it perpetuates an organisation which has existed under one designation or another since 1811. The reason for the formation of the Maritime Services Poard was the desirability of co-ordinating the port administration of the State which had previously been carried out by the Sydney Harbour Trust at Sydney and the State Navigation Department at all other ports in the State, under one authority.

The Board is a corporate body of five Commissioners appointed by the Governor by commission under the seal of the State. Three of the Commissioners are full-time members and they are responsible for the normal administrative activities of the Board. The other two are part-time members known as Nominated Commissioners. They represent such interests concerned with the administration of the Maritime Services Act as the Minister may think advisable.

JURISDICTION

The Board controls all the ports and harbours in the State from the Tweed River in the north to Twofold Bay in the south, including river entrances and ocean jetties, also the inland navigable waters of the State. In addition to the major ports of Sydney, Newcastle and Port Kembla, there are 29 other ports on the coast of this State, but some of these smaller harbours are not functioning as trading ports at present due to a number of causes including the shortage of suitable vessels, the diversion of what was formerly seaborne traffic to road and railway services, and the many difficulties experienced by the shipping interests in re-establishing the services which they were required to relinquish or curtail when so many of their vessels were requisitioned for national service during the recent war.

POWERS AND DUTIES

In its control of the ports the Board's functions consist of :

(a) The general control and management of all navigable waters and ports within the State, with jurisdiction extending to a line three miles off the coast;
(b) Administration and operation of wharves and other port facilities;
(c) Provision and maintenance of adequate harbour works, wharfage and channels at the Port of Sydney. At other ports, including Port Kembla, the Board is dependent upon the Department of Public Works to carry out all work of this nature;
(d) Control over intra-state shipping, including the survey and certification of vessels and the examination and issue of certificates to officers;
(e) Provision and administration of pilotage and other navigation services including buoys, beacons and lights; and
(f) The collection and rates and charges on goods and vessels.

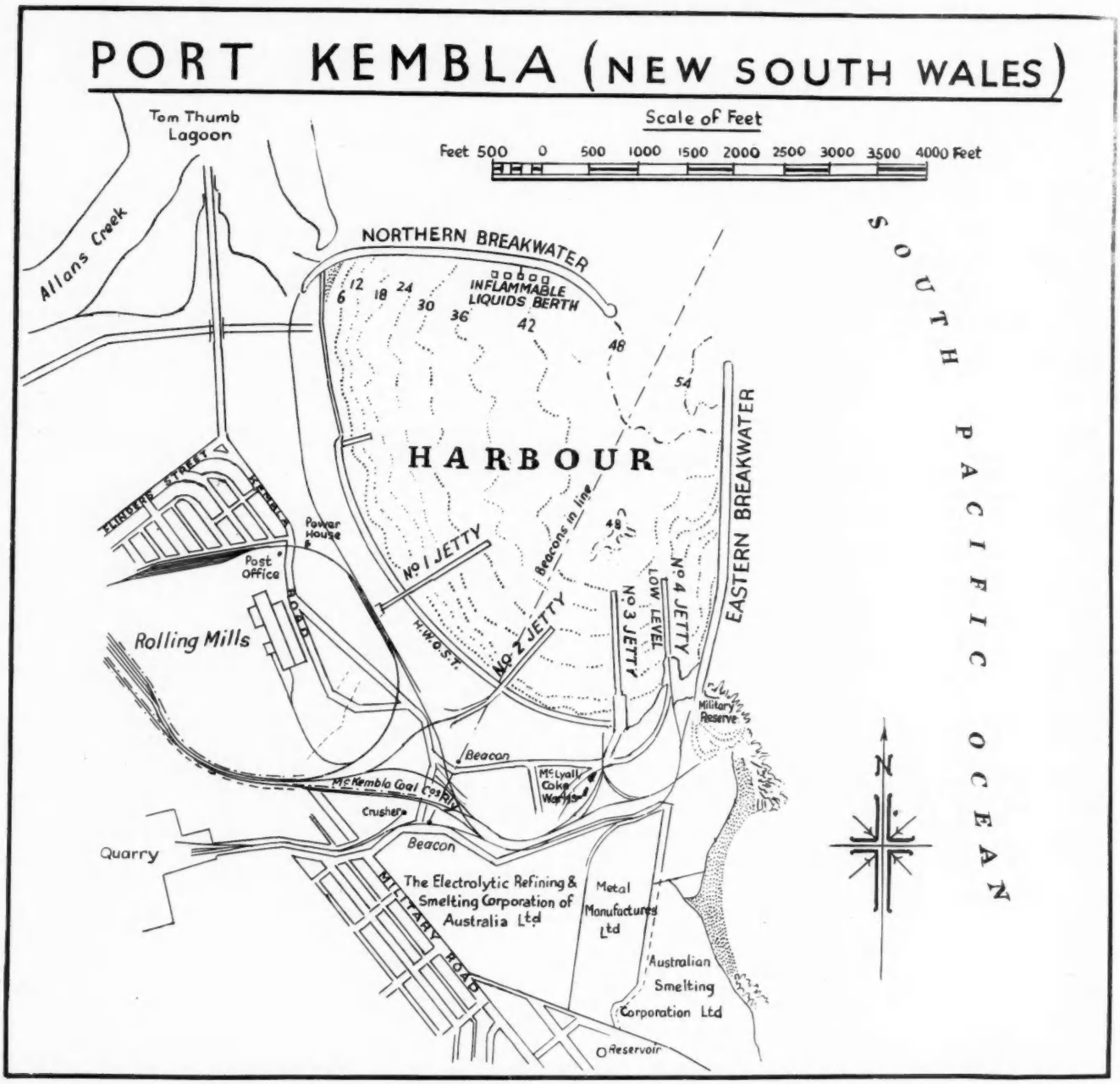
I want to emphasise that, as the port authority for the whole State, the Board is just as concerned with the management and development of Port Kembla, or Newcastle, or the Clarence River, or any of the Outports, as it is with the Port of Sydney, and takes just as much interest in one as in the other.

CAPITAL EXPENDITURE

The capital expenditure on the ports and harbours of the State is now about £23,000,000, of which slightly less than £13,000,000 has been expended at Sydney and the balance at the other ports of New South Wales, including approximately £1,780,000 at Port Kembla. The income received by the Board during the financial year ended 30th June, 1949, amounted to approximately £2,000,000, of which almost £1,600,000 was derived from the Port of Sydney, the balance of a little over £400,000 arising from

*First instalment of a Paper delivered before the Australian Institute of Metals, Port Kembla Branch, on 17th May, 1950. Reproduced with acknowledgments.

Port Administration in New South Wales—continued



the other ports and navigation services. The main sources of the Board's income comprise wharfage and harbour rates on goods and tonnage rates, pilotage fees and harbour and light rates on vessels.

The finances of the Sydney Harbour services are kept separate from the Consolidated Revenue Fund of the State, and usually show a fairly substantial credit balance each year, the net surplus for 1948/49 being nearly £128,000 after payment of all charges including Capital Debt charges.

The financial operations in respect of Port Kembla, after taking into consideration all income and expenditure items, including Capital Debt charges, result in a substantial deficit. This applies also to all the other ports of the State with the exception of the Port of Sydney. The total deficit, usually about £400,000 p.a., is borne by the Consolidated Revenue Fund of the State as a matter of Government policy.

It may be appropriate here to make a few observations on Port finances generally. I sometimes think that it is not sufficiently appreciated that the cost of providing and maintaining a self-contained port must be met from the revenue derived from the ships which use the port and the cargo which passes through the port. Port Authorities are often torn between the desire on the one hand to keep charges low and, on the other, to provide extensive modern facilities which, in the final analysis, make very little difference to the time factor in the turn-round of a ship. Some of the oldest wharves in Sydney continue to compare more than favourably in "throughput" of cargo with wharves and sheds recently completed and built in accordance with modern ideas at a high cost. The problem to be solved is to find ways and means of increasing the volume of cargo through the new and costly premises. The Maritime Services Board has given much thought to this problem without, to date, finding even a beginning to the answers. It is often said that provision of mechanical equipment would solve our difficulties, but our experience over the years is quite the reverse—use of mechanical equipment has not helped one iota as far as turn-round of ships and cargo is concerned.

Port Administration in New South Wales—continued

Sydney, of course, is particularly fortunate in that maintenance costs are low, and as a result port charges are correspondingly low. At Liverpool some 10,000,000 tons of spoil is dredged from channels in the Mersey each year while at Sydney very little maintenance dredging is necessary.

TYPES OF PORTS

The ports and harbours of this State comprise four principal types. These are (a) natural harbours such as the Port of Sydney, Port Stephens, Twofold Bay; (b) river and bar ports, such as the Clarence River, Newcastle Harbour, Lake Macquarie; (c) open roadstead ports where jetties are located at partially sheltered points on the coastline as at Byron Bay and certain south coast ports, and (d) artificial harbours formed by the construction of breakwaters and walls or by the excavation of basins. Port Kembla is one of the last-mentioned class where sheltered water has been provided by the construction of breakwaters. These breakwaters now enclose an area of approximately 330 acres with a minimum depth of 20-ft. at low water. The normal entrance between the walls is 1,300-ft. in width with a depth of 50-ft. at low water and the port is suitable for use by vessels drawing up to 30-ft.

PORT KEMBLA

EARLY HISTORY

Bass and Flinders made the first recorded visit to the Port Kembla district in 1796. The following year, in 1797, the ship, "Sydney Cove," was wrecked in Bass Strait and a survivor named Clark made his way back to Sydney on foot after walking from the 90-mile beach in Victoria. On his arrival at Sydney he reported to Governor Hunter that he had seen evidence of coal near the coast some distance to the south of Botany Bay. Mr. George Bass, possibly in view of his knowledge of the coast south of Sydney, was ordered by the Governor to investigate this discovery and, after proceeding to the district, Bass reported that he had found a reef of coal about 6-ft. in depth which had been traced for about eight miles along the face of a steep cliff. However, nearly 60 years elapsed before the Illawarra coal fields were worked. Mount Keira Colliery first commenced operations in 1854, the coal being shipped through the Port of Wollongong. From that date until 1896 various other collieries opened up some shipping their products through Wollongong or Bellambi and some from the shore at what is now known as Port Kembla.

The development of this trade prompted the colliery owners and local commercial interests to make representations for the construction of a deep sea port on the south coast and in 1896 a design for a harbour at Port Kembla was prepared by Mr. Darley, who was then Engineer-in-Chief of the Public Works Department. These plans were investigated by the Public Works Committee of Parliament and, after hearing evidence and considering claims advanced in favour of port development at Bellambi, Wollongong and Lake Illawarra, the Committee decided that a port should be constructed at Port Kembla in accordance with Mr. Darley's recommendation. An Act of Parliament authorising the construction of Port Kembla Harbour and the resumption of necessary land was passed in 1898 and preliminary work was commenced in 1900, the first stone being tipped for the eastern breakwater early in 1901. Mr. Darley's scheme had made provision for two breakwaters a northern one 3,530-ft. long and an eastern one 2,800-ft. long with an entrance width of 800-ft. enclosing an area of approximately 271 acres. However, the Act of 1898 authorised only the construction of an eastern breakwater 2,800-ft. in length.

REVISED DESIGN OF HARBOUR

As construction proceeded further consideration was given to the plans for development of the port and about 1912 Mr. Darley's scheme was revised in order to provide a greater area in the port. A committee of engineers known as the Harbour Improvement Committee finally produced a plan for a northern breakwater 3,263-ft. long and an eastern breakwater 3,750-ft. long to enclose an area of about 344 acres.

The design finally adopted made provision for a northern breakwater of about 3,200-ft. and an eastern breakwater of about 3,600-ft.

When the various designs were being investigated certain objections were raised to the proposal to provide an entrance with a northerly aspect. Although the north-easterly approach provides the most favourable direction for vessels to make the port, some engineers contended that the overlapping eastern wall would trap sand travelling from the northern beach and cause undue silting in the harbour. However, it was decided that this danger was remote and experience has vindicated this opinion as there has been very little alteration in the harbour depth and practically no dredging has been required to maintain the depth of water in the port. Almost the only dredging carried out since construction commenced in 1900 has been necessary to improve the original depth at some of the berths or to remove cargo spillage which has accumulated alongside jetties over a number of years.

CONTROL OF PORT

Prior to May, 1948, the control of Port Kembla was vested in the Department of Public Works as constructing authority, and the Department acted as agent for the Board in the exercise of functions relating to navigation and shipping. However, in view of the advanced stage of construction and following on strong representations by shipping interests, the Government decided that the control and administration of the port should be transferred to the Board, but that the Department of Public Works should continue to act as the constructing and maintenance authority as in the case of all ports in the State other than the Port of Sydney. The Board assumed the administration and navigational control of the port as from 3rd May, 1948, when a Harbour Master, Assistant Harbour Master and staff were appointed and pilotage became compulsory. The management and operation of the cranes and coal loading plant were taken over by the Board as from 1st January, 1949. Since the Board assumed control of the harbour a signal station, continuously manned, has been established and patrol officers and other staff have been employed on the wharves

SURGE AND DREDGING

Port Kembla provides a safe harbour under most conditions, but heavy weather from the south or east causes a troublesome surge in the port, and this makes it necessary at times for vessels

Entrance to Port Kembla, N.S.W. View from Signal Station looking north. In centre foreground are shown concrete blocks used for repairs to the eastern breakwater (shown on right). No. 4 Jetty is shown in left centre, with outer end of northern breakwater in background.

Port Administration in New South Wales—continued

to leave the jetties and anchor in the harbour or proceed to sea. Arrangements are in hand for thorough investigations with a view to determining the most appropriate way to reduce the effect of this surge in the port. It has been suggested that an extension of the eastern breakwater might prove the most satisfactory solution, but this will need to be determined by scale model experiments and a model of this nature is being constructed for testing purposes. However, preliminary observations have indicated that the most severe effect is felt in the section of the harbour immediately to the north of No. 1 jetty. In considering any extension of the eastern breakwater along its existing alignment, or any alignment in close proximity thereto, due regard must be paid to the fact that this work would involve an alteration in the direction of approach to the port and might finally make it necessary for vessels to navigate on a course parallel to and uncomfortably close to the beach north of the port, particularly when making the entrance. I do not need to emphasise that this necessity could be unwelcome to the masters and pilots of vessels especially in the case of ships in ballast or light trim during easterly weather.

JETTY ACCOMMODATION

About the year 1900 two coal companies operated private jetties at the site of the present port for the shipment of coal from the mines in the vicinity. Both these jetties were resumed by the Crown shortly after work commenced on the construction of the port and one formerly owned by the Mount Kembla Company was reconstructed and used up till about 1934. The other jetty, formerly owned by the Southern Coal Company, was used until 1916 when it became unsafe and the demolition and removal of this structure was completed in 1925.

NO. 4 JETTY

The No. 4 Low Level Jetty was built in 1908 in the south-eastern corner of the port. At first this jetty was 500-ft. in length, but it was extended to 800-ft. in 1929. It was originally constructed to handle the ores, fluxes and other requirements of the Electrolytic Refining and Smelting Company and Metal Manufacturers, Ltd. It is equipped with two 5-ton and one 2-ton travelling electric cranes which can be fitted with grab buckets suitable for handling bulk cargo such as phosphatic rock and sulphur. There are three standard gauge railway tracks with direct connection to the State railway system at Port Kembla.

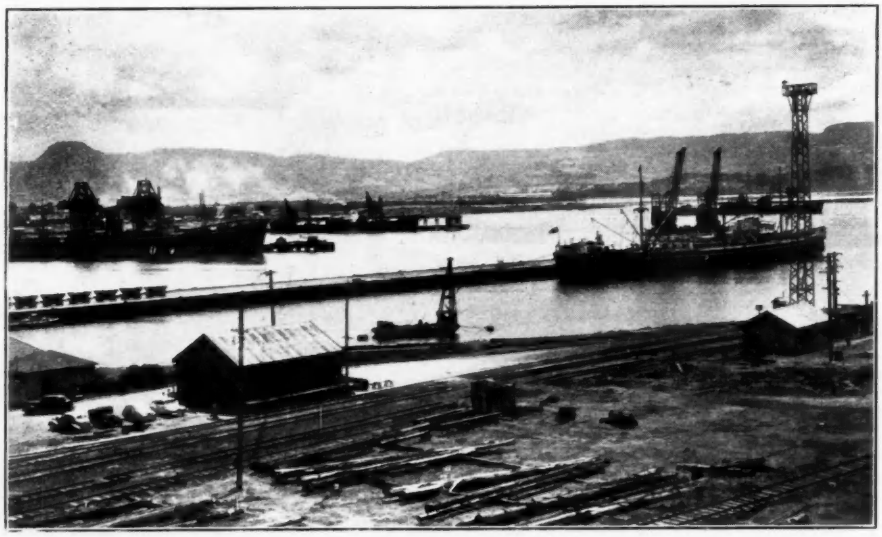
NO. 1 JETTY

The present No. 1 Jetty, used for loading coal and coke, was commenced in 1912 and was completed and put into operation in 1915. This jetty carries the coal and coke loading plant designed by the Department of Public Works and installed under contract by Messrs. Kelly and Lewis in 1914/1915. The coal or coke is brought to the base of the jetty by bottom-discharge rail trucks and is discharged into underground concrete hoppers from which it is carried by conveyor on to the main carrying belt travelling along the jetty. From this main belt coal or coke is diverted to one of the two travelling loaders which convey it by boom belt and chute into hatches in any part of a vessel. The inner loader can discharge coal into ships at a height of 39-ft. 6-in. above high water, and the outer loaded at a height of 52-ft. 3-in.

The coal plant is electrically operated and a test showed that it was capable of loading at the rate of 750 tons per hour. However, this rate has never been obtained in practice principally owing to the necessity to halt operations for trimming, and it is difficult to indicate an average rate of loading as this depends on a number of factors including the type of vessel, the accessibility of holds and hatches, and whether coal is being loaded as cargo or bunkers. On one occasion a vessel loaded 3,390 tons in actual loading time of 6 hrs. 32 min., i.e. at the rate of 519 tons per hour.

It will be of interest to compare the coal-loading facilities at No. 1 Jetty with another plant. I refer to that operated by the Baltimore and Ohio Railway Company at Curtis Bay in the U.S.A. At Curtis Bay the coal is delivered to the dumping machines in very large trucks—up to 100 tons capacity. Each dumping machine feeds coal to three belts run at a maximum speed of 500-ft. per minute, and it is stated that they can handle 80 trucks per hour. The belts convey the coal to movable loading towers which are equipped with a cage supporting a shuttle ram arrangement which can be raised or lowered to suit the height of the vessel. The shuttle ram can be extended on each side of the pier. Mechanical trimmers are fitted to the bottom of the shuttle but the coal is badly broken by their use. It is stated that 3,700 tons of coal have been placed aboard a vessel at Port Curtis in one hour, but I think about 500 tons per hour per tower is considered satisfactory.

The Baltimore and Ohio Railway Company announced recently that it is undertaking the construction of a new modern pier for handling ore imports in close proximity to the coal jetty. The new plant is expected to be ready early in 1951 and is designed to handle iron, manganese and chrome ores, at a rating of about 3,000 tons per hour. Ore unloading plant of the latest design is being installed and a belt conveyor system will transport the ore to a battery of hoppers constructed over the rail loading tracks. The whole layout is being designed so that the facilities can be duplicated if the volume of ore imports justifies such increase in capacity. The location of the new import facility close to the coal pier and its marshalling yards is a particular advantage, as the daily shipments of coal make a large number of empty rail trucks available which can be switched to the nearby ore plant, thus providing co-ordination between export coal and import ore movements with maximum efficiency in the use of rail cars and terminal facilities.



Another view of Port Kembla, showing from right to left, No. 3 Jetty, outer end of No. 2 Jetty (owned by Australian Iron and Steel Ltd.) and No. 1 Jetty in background.

NO. 3 JETTY

The present No. 3 Jetty at Port Kembla, completed in 1941, is 1,075-ft. in length, with four standard gauge rail tracks set flush with the decking. It is equipped with two electric luffing-jib travelling cranes of 20 tons capacity. The depth available in the two outer berths ranges from 42-ft. to 44-ft. at low tide.

A.I. & S. JETTY

The jetty of Australian Iron and Steel, Ltd., was built by that Company in 1929 and has special equipment for handling iron ore in bulk with two electric transporter cranes. There is direct rail connection from the jetty to the Company's works and to the State railway system, and inward cargoes of ore are loaded direct into trucks on the jetty.

OIL BERTH

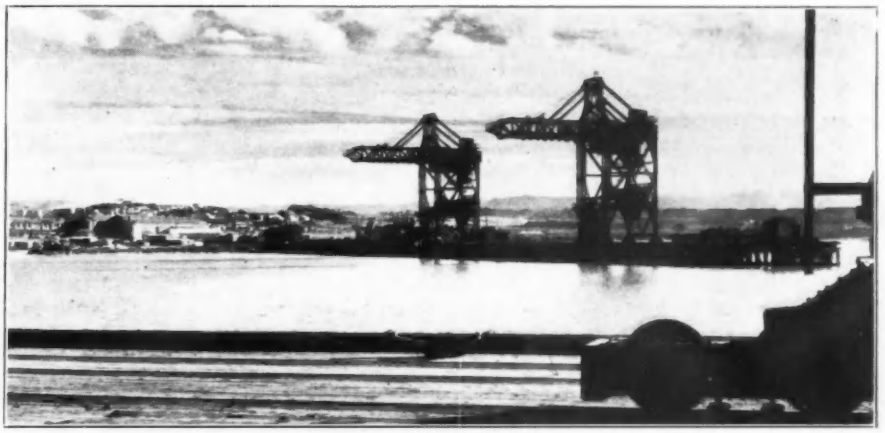
The inflammable liquid berth at the northern breakwater was built in 1939 and consists

Port Administration in New South Wales—continued

of a central dolphin with four flanking dolphins providing a total berthing frontage of 470-ft. The centre dolphin is connected to the northern breakwater and an oil pipe line is laid from this dolphin to oil depots on shore.

POSSIBLE FUTURE DEVELOPMENT

When designs for the port were first drawn up it was anticipated that future expansion of wharfage could be provided in the form of an additional jetty at the northern end of the harbour or another berth along the northern breakwater between the inflammable liquid berth and the shore. However, these proposals have been abandoned for a number of reasons including the extent of range at the first mentioned site and the difficulty of providing satisfactory approaches along the breakwater to serve the latter site. Investigations are proceeding at present in connection with suggestions for the construction of an Inner Basin at what is now known as Tom Thumb Lagoon with access from the existing harbour at about the point where the northern breakwater joins the shore. The Board has appointed a " fact finding " committee, with myself as Chairman, to assemble all available information to asist in connection with its planning for the development of Port Kembla generally and that Committee is now engaged on this work.



Jetty of Australian Iron and Steel Ltd., Port Kembla, showing the ore unloading equipment.

It is known that a very considerable amount of rock removal is involved to provide the necessary depth of water in the entrance to the Basin and in portion of the Basin itself, owing to its nature, work of this type takes a long time to complete and is very costly so that, obviously, provision of an Inner Basin of the type that has been suggested would involve many years of work.

There are many factors to be taken into consideration and a number of problems to be overcome. In addition to the economic aspect, these include measures to ensure that the Inner Basin, if constructed, would not be unduly affected by sand due to wave action from the present harbour, planning of road and rail access and communications in the vicinity, and the layout of wharfage and associated facilities to the best advantage of all interests concerned. Proposals are also under consideration for the provision of improved berths for bulk oil vessels by constructing sufficient jetties at a suitable angle in a south-easterly direction from the northern breakwater. These would replace the present inflammable liquids dolphin berth.

TRADE AND SHIPPING

As indicated earlier in this address the port started originally as a shipping point for coal exclusively, and as far back as 1895 approximately 233,500 tons of coal were handled from the two open roadstead jetties then in operation. By 1915 coal shipments had increased to a little over 290,000 tons per annum, there being at that time only one other major industry in operation at the port. However, the coal export trade is now of secondary importance at Port Kembla, the tonnages having dropped from a maximum of between 300,000 and 350,000 per year in the early 1920's to less than a quarter of those figures during recent years. On the other hand, exports of coke form an important part of the outward trade, most of this going interstate to Whyalla for use in heavy industries, and tonnages ranging up to about 250,000 tons have been handled during recent years. It is a fact, however, that the bulk of the present export trade consists of the finished products of the various industries now operating at Port Kembla, just as imports for those industries form practically the whole of the inward trade, particularly ores of various types, limestone, and concentrates.

A noticeable feature of the trade is the decline in the export of fertiliser by sea. Although import of phosphate rock is now back to pre-war figures, the export of the finished fertiliser has almost ceased indicating more intensive use of land transport for distribution of this item within the country. Another feature is the growth of bulk oil imports which have ranged up to about 60,000 tons in one recent year.

The peak year for both shipping and trade was 1939/40 when 961 vessels with a total net tonnage of 1,337,700 tons used the port and handled more than 2,000,000 tons of inward and outward cargo.

The development of seaborne trade through Port Kembla may be seen as a series of more or less distinct stages.

Up to the end of last century trade was confined to a single commodity, viz., coal. Approximately one-quarter of a million tons was exported annually at that time and this figure was maintained and increased until the early 'twenties of the present century, when it commenced to decline and at the present day is down to relatively small proportions. Local consumption, of course, is now so great that little is left for export orders.

The second phase of development is characterised by the advent of industries into the area. Electrolytic Refining and Smelting Company arrived in 1908 and was followed by Metal Manufactures Ltd., Australian Fertilisers and others by the end of the First World War. These companies all became firmly established and the gradual broadening of their activities was accompanied by an expansion of trade.

The third stage was marked by the transfer from Lithgow of the steel industry formerly conducted by Hoskins Iron and Steel, Ltd. and subsequently known as Australian Iron and Steel, Ltd. The advent of the steelworks around 1928 accelerated development in no uncertain fashion. This development was braked somewhat by the depression of the 'thirties, but resumed strongly in the subsequent recovery period.

The fourth stage coincides with the period of World War II. The essential part played by the metal industries in the prosecution of the war added strong impetus to the growth of the established industries, and trade expanded strongly in consequence.

The end of the war was followed in succession by recession, adjustment, and recovery and resumption of earlier trends.

(To be continued)

LIFT FOR NEW DRY DOCK

In our January issue short details were given of the new 700-ft. dry dock to be built at the yard of Smith's Dock Company, Ltd., North Shields. We have now been informed that a feature of the dock will be a lift shaft with a " basement " entrance leading into the bottom of the dock. The dock will be cut into an old ballast hill, and when completed, the coping level will be 47-ft. below the surrounding bank. The lift will facilitate the flow of men and materials to the dock bottom. It will descend the 47-ft. to dock level and then go below ground to the bottom level. A tunnel will lead from the bottom of the shaft into the dock bottom with a watertight door to seal it off when the dock is filled with water. The head of the lift shaft will be connected to the bank top by a footbridge.

Fenders for Persian Gulf Port

Latest Type Installed at Mena al Ahmadi

The Shell Petroleum Company, Ltd., have given details of some new suspended fenders which have been installed at the port of Mena al Ahmadi, in the Persian Gulf. It is claimed that they will overcome the difficulties of berthing ships alongside quays in heavy weather.

Forty-four sets of fenders have been fitted, designed to swing both inwards and upwards in response to the pressure exerted on them by a ship, thus providing a much greater shock absorbing capacity than previous types. The suspended or gravity fender was invented by Professor A. L. L. Baker, of the Imperial College of Science, London, and was first used, in a modified design, on the jetty attached to the Shell Petroleum Company's refinery installations at Heysham, in Lancashire.

The loading jetty at Mena al Ahmadi is T-shaped, the extension from the shore being 4140-ft. long. The northern arm is 2,800-ft. long, and the southern arm is a little under half that length. As the coast is exposed, and frequently subjected to high winds, the suspended fender was adopted as giving the maximum protection to both the jetty and the ships using it.

The 44 sets of fenders are placed at intervals of from 135-ft. to 165-ft. Each unit consists of three cylinders, just over 21-ft. high and with a diameter of 6-ft., which are filled with concrete and weigh a total of about 50 tons. The fender, which is faced on the seaward side with 14-in. timbers, is suspended by two upper and two lower links or chains to the side of the jetty. A blow impinging on the face of the fender causes it to take an upward and inward path, the extent of movement depending on the magnitude of the blow. The amount of energy absorbed is proportional to the weight of the fender and the distance it is raised. The force transmitted to the structure is proportional to the inward movement and also to the kinetic energy of a vessel striking it.

The fenders are considered to be capable of absorbing a pressure of about 200 tons from a ship coming alongside the jetty, the cushioning effect safeguarding vessel and jetty alike.

Medical Centres for Dockers

New Building Opened at Southampton

A medical centre in Southampton New Docks, which is the prototype for those to be erected at other ports by the National Dock Labour Board, was opened early last month by the Mayor of Southampton, Alderman Dr. G. H. Barendt, in the absence through illness of Mr. Arthur Bird, chairman of the Board's National Welfare Committee. The centre is a single-storey building comprising a well-equipped waiting room, surgery, treatment room and rest room and accommodation for medical staff.

Speaking at a luncheon which followed the opening ceremony, Mr. J. Buchanan said it was not easy to estimate the value of a medical centre in the profit and loss account, but they knew from experience it did reduce lost working time following minor injuries and accidents. Immediate attention also went a long way towards eliminating serious consequences which sometimes followed a comparatively trivial injury.

The Mayor said that as a doctor he regarded the Centre as a thoroughly worthwhile humanitarian enterprise. In cases of accident it was of utmost importance that facilities should be available for first-aid and follow-up treatment.

Other speakers said that the new venture would be a medium for close and better understanding between employers and men, and would pay a handsome dividend.

A medical centre which was opened in Southampton Old Docks in December, 1949, has treated over 6000 cases.

Centre Planned for Grangemouth

A scheme for a new medical centre, canteen and call stand for Grangemouth dockers has also been approved, and plans were passed by the Grangemouth Guild Court at a meeting held towards the end of last month. The buildings, which are being erected by the National Dock Labour Board in the dock area, will cost £18,500.

Correspondence

To the Editor of *The Dock and Harbour Authority*.

Inland Waterways

Sir,—I found the article by Mr. E. C. Jones in your December issue, on the subject of Future Policy and Towage Methods, most interesting.

1. Regarding his "Bantam" system of towage, he rightly does not claim that it could be employed on all waterways for all traffic. That it has interesting possibilities for short distance dry cargo canal traffic seems clear; as the inventor of a towage system it is hardly to be expected that he would enthuse over the modern medium-powered, deck-controlled, self-propelled vessel which, with its flexibility, is capable of considerable tonnage throughput, one of the basic essentials in reducing operating costs.

2. Mr. Jones's general views on inland waterways policy are very similar to my own; in the operation of tank barges we have proved by experience that the bigger the boat the cheaper the cost; this must surely apply, even if not to the same extent, when dealing with bulk dry cargo; so when he says "it is necessary to trade the estuary craft as far inland as possible" I feel he hits the nail neatly on the head. I believe, therefore, that the cornerstone of the policy for the development of inland waterways should be to work upwards from the four main estuaries, i.e. the Thames, Humber, Mersey and Severn; development of waterways which could never accommodate an estuarial type of boat of at least 100 tons capacity or, if possible, 200 tons capacity, is, in my opinion, money wasted. The new Lock at Newark is a welcome step in the right direction. Much can be done to make the Severn route suitable for larger craft, particularly with regard to draft of water.

3. There are many waterways being kept open at a loss, and with little or no prospect of ever attracting sufficient traffic to operate at a profit; this is due, in some cases, to the fact that they pass through districts where there is insufficient traffic, and in most other cases to the fact that the size of craft which can be accommodated cannot compete with transport by rail or road.

4. The case I have particularly in mind is the Kennet and Avon Canal, which was taken over from the Great Western Railway by the Docks and Inland Waterways Executive. I think it is common knowledge that this canal has an operating deficiency at the rate of about £30,000 per annum. What little commercial traffic there is takes place along the western extremity between Bristol and Bath. In the past, pleasure boats have generally only used the canal between Reading and Newbury. Last May, owing to the unsafe condition of several locks between Reading and Newbury, it was decided to close this section of the navigation. This immediately invoked howls of protest from a number of well-intentioned enthusiasts whose love of the canal is not dissimilar to the Light Railways Transport League's love of the tram.

5. As a result of their vociference the Docks and Inland Waterways Executive bowed to the storm; in July a press statement was issued that work would be undertaken on the re-construction of two locks and the renewal of several pairs of gates in intervening locks to enable the canal to re-open by the middle of 1951. This work will probably cost in the region of £50,000.

6. Commercial traffic in this section is at present nil; prospects of any other than low grade short distance traffic is extremely remote; in any case, there could hardly be sufficient to justify the outlay, to which would have to be added perhaps a further £50,000 for dredging and other arrears of maintenance, as in places there is barely 2-ft. of water.

7. It seems, therefore, that in addition to an annual operating loss of £30,000 per annum, a further £50,000 from public funds is being spent for the benefit of pleasure boats, whose contribution to the revenue of the canal can be estimated at well under £1,000 per annum.

Yours faithfully,

Harker House, Knottingley, Yorks. G. L. LYON.

1st January, 1951.

Bulk-Handling Plant for Port of Baltimore

Construction of New Pier for Iron Ore Imports

By GEORGE W. GRUPP.

THE Baltimore & Ohio Railroad is building one of the largest seaport iron ore handling plants in the world at a cost of $5,000,000 because of the belief that Baltimore is destined to become one of the most important ports of the United States which will be engaged in that trade as domestic resources shrink.

The pier was designed by the engineering staff of the Railroad Company and the construction work is being done by three contractors, who will complete the project by January, 1951. The Arundel Corporation of Baltimore is doing the dredging work; the Empire Construction Company of Baltimore is building the substructure of the pier; and the Dravo Corporation of Pittsburgh is furnishing, erecting and putting into operation all the ore handling facilities, including the two unloaders, conveyor system and discharge bins.

The Baltimore & Ohio pier will be used primarily for the handling of imported iron ore, but at other times it will be used to handle imported chrome and manganese ores. It is expected that the first shipments to arrive at the Baltimore & Ohio ore pier will be cargoes of iron ore from Liberia, where a 43-mile railroad is under construction to connect the iron ore mines with the port of Monrovia.

In planning this pier, the Baltimore & Ohio Railway recognised that its 6,200 miles of line, with a total trackage of 12,087 miles, serves many of the steel production centres, and a great industrial area, of the United States. It is also not unmindful that the freight rates between Baltimore and this industrial area are lower, or equal, to those rates to competing seaports. Moreover, it is aware that Baltimore is the nearest seaport to many points in the industrial heart of the United States and to the key steel manufacturing towns of Pittsburg, Youngstown, Cleveland and Chicago, as can be seen from the accompanying table.

RAILROAD DISTANCES IN MILES.

From:	To: Baltimore.	Philadelphia.	New York.
Akron, Ohio	429	456	550
Chicago, Illinois	767	814	890
Cincinnati, Ohio	560	644	724
Cleveland, Ohio	444	490	562
Columbus, Ohio	479	545	621
Detroit, Michigan	604	637	631
Indianapolis, Indiana ...	650	723	799
Louisville, Kentucky ...	688	772	852
Pittsburgh, Pennsylvania ...	313	360	426
St. Louis, Missouri	891	964	1,040
Toledo, Ohio	548	595	668
Wheeling, West Virginia ...	336	403	480
Youngstown, Ohio ...	378	424	500

Baltimore, one of the five principal United States North Atlantic seaports, located at the head of the Chesapeake Bay which penetrates deeply into the interior from the Atlantic Ocean, has been an international seaport since 1706.

Three trunk line railroads, the Western Maryland, the Pennsylvania, and the Baltimore & Ohio, connect the port of Baltimore to most of the important points located between the Atlantic seaboard and the Mississippi River north of the Potomac and Ohio rivers.

These railroads have contributed greatly in making Baltimore a major gateway to the interior of the United States.

To-day 70 American and foreign shipping companies maintain an average of 279 sailings per month to over 200 foreign and domestic ports from Baltimore's 270 piers, docks and wharves, which have up to 50 feet of water alongside their 58,605 lineal feet of berthing space.

These marine terminal facilities are spread out along the port's 127 miles of shore frontage owned by the city, by individuals, by industrial companies, and by the railroads. They include 2,858,590 square feet of warehouse floor space and railway trackage to 23,000 freight cars and are centres of great activity in handling the port's traffic of coal, fertilizer, grain, iron and steel products, lumber, metals and ores, molasses, petroleum, sugar and general cargo. The most important of these facilities are owned and operated by the railroads.

The inhabitants of Baltimore are not satisfied, however, with the present facilities, which include ship repairing, bunkering and material handling services for vessels using the port, and an extensive $80,000,000 port development and improvement plan is being currently considered by both private and public interests.

One of the projects to improve the port's facilities is the building of the Baltimore & Ohio Railroad Co.'s import ore handling pier. The Republic Steel Company plans to import, through this pier, about 1,000,000 tons of Liberian iron ore per year, beginning in 1951. The United States Steel Corporation also proposes to import iron ore through the port of Baltimore from Venezuela in 1953.

With the completion of the ore pier, and with the existing ore handling facilities of the port, it is the opinion of Mr. G. Harry Pouder, of the Baltimore Association of Commerce, that "Baltimore will be in an exceptionally splendid position not only to handle ores from Chile, Venezuela and Brazil, but to discharge ore from two anticipated rich sources of future supply, namely, Liberia and Labrador."

Since 1920 the steel industry has been aware that the high grade hematite ore of the Mesabi Range (Lake Superior region), which currently supplies 82 per cent. of the iron ore needs of the United States, may be depleted by about 1970. For this reason it has been making experiments to find economical methods for the utilization of domestic low iron content taconite ores, and in exploring for new sources of high iron content hematite ores.

The cost of water transportation, it is believed, will be low enough to permit the importation of high grade hematite ores to compete with the high cost of processing domestic low grade taconite ores. And since Baltimore is within easy reach of many of the important steel producing centres, it is natural for this port to develop into the major iron ore import seaport of the United States. Foreseeing this, the Railway Company designed its ore handling pier so that it can be easily and quickly extended when the volume of traffic justifies such expansion.

For some years the importation of iron ores has steadily increased. In 1949 the United States imported 8,300,000 tons of iron ores from 18 different countries as compared with 3,085,000 tons in 1946. This rate of increase will be much greater when we begin to import from the rich iron resources of Labrador, Liberia and Venezuela. In fact, it has been estimated that by 1960 the steel companies of the United States will import annually 20,000,000 tons from Venezuela, 10,000,000 tons from Labrador, 1,000,000 tons from Liberia, and 10,000,000 tons from other countries. At present shipments are being delayed because it is necessary to build mining towns, railroads and terminal facilities for the new ore fields. Then, too, it will require a few years to build the proposed 25,000 tons capacity super-cargo vessels. Two cargo vessels for this trade are being now constructed in British shipyards.

It is believed that Venezeula iron ore will be shipped to the United States Gulf area through the port of Mobile, Alabama, and the ore destined for the North Atlantic seaboard, Pittsburgh and Youngstown areas of the United States will pass through the port of Baltimore, which is 2,400 miles from Venezuela. Labrador iron ore will flow to the steel centres of the Lake Erie area, via

Bulk-Handling Plant for Port of Baltimore—continued

Baltimore, which is 1,600 miles from the Three Sister Islands, until the St. Lawrence Seaway is built.

The Baltimore & Ohio Railroad, the oldest railroad in the United States (chartered in February, 1827), controls more than 60 per cent. of Baltimore's railway trackage and sidings, 297,824 square feet of occupiable warehouse floor space, 3,800,000 bushels of grain elevator capacity, 12,425 lineal feet of water frontage and 14 piers, exclusive of the iron ore pier now under construction.

The Company's new ore pier, which will have a capacity to handle 2,400 tons per hour, will eventually exceed the capacity of any of the other four ore handling piers in Baltimore owned and operated by the Bethlehem Steel Company, and by the Western Maryland, Pennsylvania and Canton railroads. The combined capacity of the four existing ore handling piers is only 4,000 tons per hour.

The new ore pier now under construction will be located on Stone House Cove, Curtis Bay, Baltimore, adjacent to the Company's export coal pier and extensive supporting classification yards. Here the daily unloading of coal makes available a large number of empty cars for quick switching to the ore pier for loading and rapid assembly into ore trains, which can by-pass the heavy inter-city freight and passenger train traffic of Baltimore in their movement to the steel centres of Pennsylvania and Ohio.

Obviously this location permits maximum efficiency in the usage of freight cars and terminal facilities. In addition, it makes it easy to shift the vessels to the coal pier for outbound loads of coal for the distance between the coal pier and the ore pier is less than 2,000 feet.

Representatives of the steel industry are satisfied that the ore pier is being built in the best location. Since it is being constructed at the lower end of the port, the chances of vessel collision and possible delays during foggy weather are much less than if it were located in the more highly traffic congested areas.

The winters of Baltimore are usually mild because the prevailing wind throughout the year is from the south-west, except during the summer months of August and September, when it is from the south. Occasionally, when the temperature drops below the normal winter average of 35 degrees Fahrenheit, the Patapsco River may freeze over, but municipal icebreakers quickly open the port's channels so that vessels have little or no difficulty entering or leaving the port during the cold weather season.

The Curtis Bay channel, which extends from the port's main channel to the approaches of the Baltimore & Ohio Co.'s coal pier and new ore pier, has a mean low water depth of 35 feet. It is two and one-fifth miles long and 400 feet wide, except where there is a turning basin about 750 × 2,000 feet. The water depth alongside and adjacent to the coal pier is 35 to 37 feet. To permit the easy manœuvring of large vessels between and alongside the coal pier and the new ore pier, a channel is being dredged to a mean low water depth of 39 feet, which is expected to be completed shortly.

On this work the Arundel Corporation of Baltimore is using a dipper dredge, which has a 10 cubic yard capacity bucket and dipper stick which can excavate to a depth of 50 feet below mean low water. After the material has been excavated, it is then loaded into bottom dump scows which are towed to and unloaded at a point in the Chesapeake Bay, about 23 miles from the site of the ore pier.

The sub-structure of the open deck 650 foot ore import pier is being built by the Empire Construction Company of Baltimore —contractors and engineers of heavy construction work.

This ore pier, the first of its kind to be built by any railroad on the Atlantic seaboard, will have sufficient berthing space to accommodate the largest ocean-going ore carriers. And its design characteristics make it easy to make extensions when traffic warrants such expansion.

The retaining wall of the pier will be faced with steel sheet piling 60 feet long. When this is completed, the contractor's power

An aerial view of the port of Baltimore, Maryland.

Bulk-Handling Plant for Port of Baltimore—continued

shovels will excavate the mud and unstable materials, which will be carted away in heavy duty dump trucks. The removed soil will be replaced, as well as additional necessary material, with backfill of sand and slag.

In this area of solid fill will be driven hundreds of steel shelled concrete piles to support the runways and docking apron.

Four rows of 50 foot concrete bearing piles, 3 feet 6 inch centres, and spaced at 5 feet centres along the pier, will support a 498 foot long and 15 foot 9 inch docking apron and the outer concrete wall supporting the runway of the unloading machines.

Similarly spaced, two rows of 40 foot concrete bearing piles and one row of concrete batter piles will support and brace the inner concrete runway for the unloading machines.

The water side and land side concrete runways are connected by steel tie rods anchored in the concrete bases. These tie rods are spaced 6 feet apart the entire length of the pier. Each tie rod is provided with two turnbuckles to make any necessary adjustments for stabilization purposes.

Since the pier will not have a deck floor, the concrete foundations for the belt conveyor system, and the footwalk on each side of it, will be supported by cantilever concrete construction from the outer runway wall.

The fresh water pipe line will be laid in the backfill soil. This water pipe line, which will supply water to vessels and provide water for fire protection purposes, will have two outlets along the docking apron.

A 5 foot wide timber fender system with a bottom level of 2 feet 6 inches above mean low water, and with a top level 1 foot below the top level of the docking apron, will protect the pier.

The end section consists of five 12 × 12 inch greenheart rubbing strip timbers, which are fitted snugly together in a horizontal position against the face of the pier between angles attached to the steel sheet piling. These timbers are fastened to the angles with 1 inch steel rods which penetrate through the timbers' centres. The angles and rods are spaced 5 feet from centre to centre.

Along the rest of the pier's face the fender system omits the three centre horizontal timbers. Instead, at 12 foot intervals, vertical 12 × 12 inch timbers are fastened to the 12 × 12 inch top and bottom horizontal timbers.

At the outer corner of the pier there will be a cluster of 19 inner piles of greenheart and 18 outer piles of treated white oak, all securely fastened together with $\frac{7}{8}$ inch steel cables.

Eighteen mooring posts will be properly spaced along the docking apron. They will be made of concrete filled steel pipes 20 inches in diameter and 5 feet long. They will be anchored in 3 feet of concrete of the docking apron.

The pier will be equipped with an electric fire alarm system. An electric lighting system will extend along the conveyor system, on the unloading machines, and along the docking apron. Navigational lights will be installed on the pier.

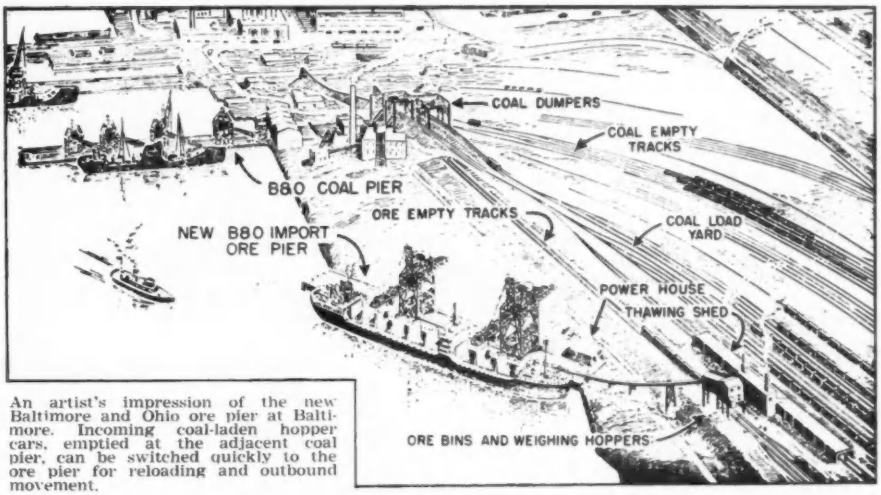
The material handling equipment of the pier is being made by the Dravo Corporation of Pittsburgh—builders of machinery, marine terminals, barges and towboats. The equipment they are building for the ore pier consists of a belt conveyor system and two 1,200 tons per hour ore handling machines.

The belt conveyor system will transport the ore to a 500 ton capacity hopper constructed over two railroad loading tracks. Beneath this hopper there will be built four 40-ton capacity loading and weighing hoppers (two will be located over each loading track), which will be equipped with automatic weighing devices so that the proper amount of ore is discharged to prevent freight car overloading.

These weighing devices and all other parts of the material handling equipment will be operated with the latest types of electric automatic and semi-automatic controls.

Each of the unloading machines will be of the one-man tower type, which consists of a steel frame tower with one fixed boom of the cantilever bridge type with a maximum reach of 65 feet, and one hinged boom with a maximum reach of 70 feet. Both booms will be traversed by the man-trolley which carries the bucket hoist, control house and operator's cab.

The hinged boom will be raised when not in use to clear the masts of vessels as they come alongside the pier. It will be lifted by a series of $\frac{7}{8}$ inch hemp core steel wire ropes, and will be securely held in a lifted position by an apron latch fastened to the top of the tower frame. When the boom is lowered into an unloading position, 67 feet above mean low water, it will be supported by two pairs of folding suspension bars.



An artist's impression of the new Baltimore and Ohio ore pier at Baltimore. Incoming coal-laden hopper cars, emptied at the adjacent coal pier, can be switched quickly to the ore pier for reloading and outbound movement.

The 15 net tons, or 200 cubic feet, capacity grab bucket of the hoisting unit of each machine will be operated from controls located in the travelling operator's cab on the man trolley. After the bucket is loaded and hoisted, the trolley will then move along the boom to the 100 ton capacity hopper inside the tower frame, which will feed the belt conveyor system. In case railroad freight cars are not available to utilise the conveyor system, then the trolley unit will move to the other side of the tower along the fixed cantilever bridge type of boom to discharge the ore in the contemplated emergency storage pile area which will be located adjacent to the inner runway of the machines.

Each tower, which will have a 65 foot span, will be mounted on four sets, or trucks, each consisting of eight electric power driven wheels. In other words, the weight of each unloading machine will rest on 32 power wheels—four pair on each corner—which will roll on two sets of 2 foot 6 inch gauge runway rails, one set on each side of the tower, along the 498 foot runway.

After the iron ore has been discharged from the vessel into the 100-ton capacity tower receiving hopper of each unloading machine, it is then delivered by heavy manganese variable speed feeders to the belt conveyor. This 4 foot belt, which will have a capacity of 2,000 tons per hour, will deliver the ore to the 500-ton capacity discharge bin, which will also be equipped with feeders and with weighing hoppers for discharging ore into the awaiting railroad freight cars.

This conveyor system, which will be 856 feet long, will operate along a level distance for about 467 feet and then on a 16 degree grade for a distance of 389 feet to the railroad car loading bin. The operator and conveyor drive houses will be adjacent to the discharge bin.

There will be a footwalk on each side of the inclined portion of the belt conveyor to make it easy to inspect, service and repair the belt and the troughing idlers. The supporting structure of the conveyor system will be of concrete and steel construction.

Three railroad tracks will pass under the discharge bin. Each of the two outer tracks will pass directly under two of the four weighing hoppers, which will be loaded from the 500-ton capacity

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The Tides and Drainage

Their Influence on Land and Sewerage Outfall Design

By JOHN T. CALVERT, M.A., M.I.C.E., F.I.San.E.

(concluded from page 277)

The discussion which followed the Paper entitled " The Moon and Drainage " which was originally read by Mr. J. T. Calvert before a Sessional Meeting of the Institution of Sanitary Engineers, London, contains many points which are likely to be of interest to readers of this Journal. Accordingly we are, by kind permission of the Institute, printing excerpts from some of the remarks made at the Meeting.

DISCUSSION

Mr. L. B. Escritt, after proposing a vote of thanks to Mr. Calvert for his paper, said the subject was one which many sanitary engineers did not encounter in the course of their professional lives. But some had had opportunities to deal with tidal problems and to gain that specialised knowledge which made it possible to design schemes that were economical in the complex conditions applying. Mr. Calvert was one of those who had had such experience.

Very seldom had the subject been discused in papers. A text book on " Sewerage of Seacoast Towns," had been written by H. C. Adams, early in the century, a paper had been presented by Mr. Godfrey Taylor, in Ireland, some years ago on a different aspect of sea outfalls; and some statistics had been collected by the late Harold W. Boardman, on the extent to which various degrees of treatment were applied. It was because the subject was so infrequently discussed that Mr. Calvert's paper was particularly interesting at the present time; he had rendered great service by re-opening the subject.

Sea outfall work, like any other sewerage problem, was an economic problem. That applied particularly to a surface-water system, where one had to make a guess as to the amount of money that should be spent to prevent damage due to flooding. Most engineers would agree with Mr. Calvert's view that it was unreasonable to design a sea outfall to cater for a maximum intensity of rainfall coincident with an exceptionally high tide. Surface water and combined sewers generally were designed to accommodate the most severe storms likely to occur not more frequently than once a year. The same rule could, therefore, be applied with reason to sea outfalls, *i.e.*, an outfall should be so designed that the combined effect of rainfall and tidal conditions would not produce surcharge in the sewerage system as often as once a year. In some cases it had been assumed that, when the sewers were flowing full under the effect of the " once-a-year storm," the outfall was discharging into the sea standing at high-water level ordinary spring tides. In that connection Mr. Escritt mentioned that the fact that sea water was heavier than sewage was often neglected in outfall calculations, which were therefore inaccurate.

Perhaps the most interesting problem touched on by Mr. Calvert was the design of storage tanks discharging through outfalls into tidal waters. Mr. Calvert had said that that hydraulic problem could safely be left to mathematicians with plenty of time and patience. Mr. Escritt considered that they would need *considerable* time and patience, seeing that the simplest practical case—that of a tank having vertical sides, a constant inflow and discharge into a tide varying strictly as the sine curve—had so far proved insoluble as a practical mathematical problem. J. R. Daymond (*Journal Inst. C.E., No.* 3, 1939/40), who had studied that problem, had found that it reduced to a differential equation which could not be solved explicitly, whilst an alegbraic solution was too complex to be of practical use; Daymond had, therefore, prepared graphs based on experiments. However, the cases that occurred in practice were usually complicated beyond the simplest case, and they were in fact tackled, not by mathematicians, but in the engineer's drawing office with the aid of stage-by-stage approximations.

When surface water was pumped into the sea and storage was allowed for in tanks, ditches, etc., a simpler and yet still interesting problem was involved. The amount of storage required to allow for accommodating the storm liable to occur once a year could be found by the formula:—

$$s = \frac{1}{10\,p^{0.6}}$$

where s = storage capacity in terms of inches rainfall over the impervious area drained.

p = constant rate of pumping in terms of inches rainfall per hour over the impervious area drained.

Similar formulae could be found to apply to storms of less frequent occurrence.

On this matter of pumping sewage against the tide, Mr. Escritt pointed out that this was one occasion for considering reciprocating pumps because they were capable of functioning against very varied heads, whereas centrifugal pumps, when called upon to function against extremes of head, gave low efficiencies and sometimes tended to overload the motors.

Mr. J. H. Walton, who expressed agreement generally with the statements made in the paper, first quoted the author's statement that " Hydraulically, the simplest case of drainage occurs where the outlet is into a canal which maintains a constant level and given the rate of discharge to be dealt with the selection of a suitably sized pipe requires merely a reference to the correct tables. Very little judgment is needed except perhaps in the selection of the tables." Was not the main problem here by-passed with the words " given the rate of discharge." He thought that there was much to be done towards improving the estimate of the rate of flow. He did not think we had by any means reached the final answer on that subject.

Then Mr. Calvert had expressed the opinion that it was unreasonable to design a sea outfall to cater for a maximum intensity of rainfall coincident with an exceptionally high tide. That was true, of course, said Mr. Walton; but it must be borne in mind that the worst tides were the equinoctial tides, and the autumnal equinox in particular was apt to coincide with some of the worst weather in the year. So that it might be wise to consider the size of pipe required to restrict flooding to a certain frequency (including the effect of tides), which would be decided by the type of area to be drained, rather than to consider the drainage separately from the tidal question as was normally done.

In regard to pumping outfalls, Mr. Walton drew attention to the statement in the paper that " . . . in general when pumps have to be installed the additional cost of lifting to the level of the highest known tide is negligible. . . . " That was true, he said, and he supposed that it was normally done. But he knew of two cases in which some savings in running costs were effected. In one of these there was a large dyke between the site of the pump house and the sea; the delivery pipe was taken over the dyke and down on the seaward side, terminating in a tank, the purpose of which was to keep the outlet of the delivery pipe sealed. There was then a syphon effect over the top of the dyke. The second case was very similar. A 30-in. axial flow pump was used, and

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discharge bin. The centre, or pusher, track will be used by an electric pusher locomotive equipped with movable bars which will extend outward when desired, so that the locomotive can push simultaneously loaded and empty cars on the two outer tracks. The loading hopper trackage facilities will be sufficient to accommodate at least 30 large hopper cars. In addition to that, the existing adjacent supporting yards can accommodate hundreds of cars.

The electric pusher locomotive will not only place empty cars under the loading hoppers, but it will also switch the loaded cars to adjacent tracks, where they will be made into solid ore trains for movement to the steel mills of Pennsylvania and Ohio.

This 2,400 tons per hour capacity ore pier of the Baltimore & Ohio Railroad will assure quick turn-around for vessels. Its conveyor system will not simply intermittently deliver iron ore to the loading hoppers, but will provide a noiseless, smooth, continuous flow of ore to the awaiting freight cars. The construction of this pier makes it clear that the Company sees Baltimore, in the future, as the leading iron ore import seaport of the United States.

The Tides and Drainage—continued

the delivery end of the pipe was always submerged. This syphon arrangement enabled one to obtain the advantage of pumping against a smaller head when the tide was low.

Coming to the problem of discharging into tidal waters, he mentioned the discharge from an airfield, where the rates of rainfall were approximately six times as great as in this country. The ground was very flat and very near to the sea coast; but the shore consisted of a line of swamps, and there were tidal gates between the swamps and the sea, it being possible to keep the water in the swamps to something like half tide level, thereby improving very greatly the drainage of the airfield, beyond that which would have been possible if the discharge had been directly into the sea.

The reference in the paper to discharging into the Humber estuary recalled his experience some years ago in connection with the construction of new outfalls for storm water and soil water from Grimsby. Although the discharge was taken out some 900-ft. beyond the low water line, the course of the foul water was very clearly marked by the presence of seagulls on the surface of the water, and on some occasions, so far as he could see, the rows of seagulls had pointed directly towards the bathing beaches. Without doubt that condition had been corrected but it seemed to indicate that it was necessary to take float readings over perhaps more than one set of ordinary spring and neap tides, because winds and so on must affect the course of the floats, and where there was a popular seaside resort it was important to keep the sewage stream away from the bathing beaches.

The Grimsby outfall was of 7-ft. 6-in. diameter precast concrete tube. He believed that at the time in question it was the largest diameter that had been made in this country, the tubes weighing five or six tons apiece.

Dealing with the references in the paper to treatment before discharge at coastal towns, Mr. Walton said he had thought that sedimentation was always required on the sea coast. He felt that the problem of the discharge of crude sewage into tidal estuaries was one requiring immediate attention.

When reading the paper he had not fully understood the description of the Warrington intercepting sewer. He gathered that there would be a number of modules; there would be one module between each sewer and the intercepting sewer, so that the module would be operated under pressure when the sewers were surcharged. He asked what was the form of the modules.

Finally, he referred to the point that bodies such as the Thames Conservancy Board, the Lancashire Rivers Board and the West Riding of Yorkshire Rivers Board had the prevention of pollution as a major pre-occupation, whereas that was not the case with bodies responsible for tidal waters. That was possibly another reason for the shocking conditions which existed in some of the estuaries.

Mr. Calvert, replying to the points raised, first supported Mr. Escritt's emphasis of the fact that drainage was an economic problem. When designing a structure such as a bridge, he said, one must consider the worst case; we could not just take the view that if too many people came on to the bridge at any one time it would have to collapse! But in connection with the construction of drainage systems human life was not generally involved, and one had to consider the economic balance between the cost of dealing with flooding and the cost of preventing it.

He was inclined to disagree with Mr. Escritt's advocacy of reciprocating pumps from one point of view. Although they were more efficient than centrifugal pumps when working against variable heads, their cost at the present time for dealing with sewage was enormous because there were so few firms making them. He had tried to obtain them recently, but the extra capital cost of acquiring reciprocating pumps of any size was much greater than the extra annual running cost of centrifugal pumps.

Next, he agreed with Mr. Walton that the subject of rainfall calculations was not yet closed.

The consideration of the influence of winds when making float experiments was certainly important, and in the paper he had pointed out that one should note the wind when recording the results. But a matter to be borne in mind particularly was that there should not be an extraordinary wind when float experiments were made. The normally prevailing wind in this country is south-west and if there were an extraordinary wind at the time of the float tests, the tests should be repeated under more normal conditions.

Mr. Calvert did not agree that sedimentation was desirable in sea coast towns. What he had stated in the paper was that he considered it to be desirable in estuaries, but not on the sea coast; he felt that where there was good point of outfall into the sea, that was all that was necessary, and nature would do the rest.

Responding to the request for further information concerning the Warrington modules, he said that before the war the engineers had arranged with the manufacturers how they were to be designed and made; but manufacturers were now so busy that there was some difficulty in getting anyone to undertake the necessary development work. The intention was to use the existing outfall sewer, with a connection made from it into a flume chamber, and the outlet to the flume would go into the intercepting sewer. As the level of the liquid rose on the upstream side of the flume in the chamber it would automatically close the pipe from the outfall sewer into the flume chamber.

Mr. H. D. Manning referred to Mr. Calvert's statement that sedimentation was not necessary at seaside towns, and submitted that unless a seaside town, particularly a bathing resort, was very favourably situated, there was often a strong case for sedimentation.

Before the war a number of seaside towns were considering, and in some cases had decided upon, the installation of sedimentation tanks before their sea outfalls. If that practice became widespread, a fundamental design problem often arose. Most of the towns were drained by a system of sewers which naturally, owing to the lie of the land, fell towards the sea and discharged through a number of outfalls. If the sewage was to be treated even by a short stage of sedimentation, it was very probably that the designers would not be able to find places on the foreshore at which the Councils would allow that treatment to be given. Sewage would therefore have to be taken to the backs of the towns for treatment, and then brought back to the outfalls on the foreshore. This would often involve pumping the whole of the sewage and considerable lengths of unproductive sewers.

Recalling a personal experience, he said that when reclining on the cliffs above a well known south coast resort he had looked out to sea and observed a brown coloured patch in the sea, thronged with seagulls. He was on the cliffs for some hours and he had watched the patch gradually change its shape and course, and eventually it had covered about 500 yards of beach.

Mr. Calvert agreed with Mr. Manning fundamentally that suitable points of outfall must be found; but the coasts to which Mr. Manning had referred were not suitable. He did not feel that, where there was a suitable point of outfall, there was any objection to the discharge of crude sewage into the sea, preferably screened, but otherwise crude.

But it was necessary to exercise care lest, in avoiding the pollution of beaches, another nuisance was created, namely due to sludge. If sedimentation tanks were established, then it was necessary to deal with the sludge, and that might create nuisance, or else very great expense would have to be incurred in getting the sewage to an isolated site.

Mr. P. Edwards, dealing with float tests, asked whether they were carried to the extent of ensuring that one's own beach was safe from pollution and never mind the next beach, or whether they were extended far out to sea.

He was prompted to ask the question because of the of the experience of a small township situated between two large townships on the south coast. A lot of material was washed on to the beach of the small township. When consideration was given to the problem, the small township had employed a small man as its representative, whereas the other two had employed big men. The man representing the western township had claimed that the nuisance came from the east, or else it was produced by the small township itself; the man representing the eastern neighbour had said that the nuisance came from the west or was produced by the small township itself. There the matter rested.

Mr. Calvert said he certainly would not agree with shifting the nuisance to an adjacent beach. But he felt that the problem of

The Tides and Drainage—continued

discharging without nuisance was one of time rather than one of distance. If the sewage were carried out to sea, so much the better; but he believed that the floats should be followed for a period of 4—6 hours, for by that time the surface waves would have brought about sufficient mixing to avoid nuisance on the beach, if the coarse solids were removed.

The President asked if it were not advisable in tidal estuaries to carry out float tests to ensure that the effluent would be carried into the main flow of the water, preferably in mid-stream, to ensure that it would not be brought back with the change of tide. In that connection he said he believed the discharge of effluent from the West Middlesex works was carried to an island in the middle of the River Thames through up-stand pipes, to ensure that the effluent would be discharged into an appreciable volume of water in mid-stream.

Mr. Calvert agreed that discharge from the banks into a tidal estuary was not desirable, if it could be avoided, and in reply to the question whether the same degree of oxidation was effected in sea water as in fresh water, or whether oxidation took place at the same rate in the two cases, said he believed the rate of solution in salt water was rather less than in fresh water, but since reading the paper he has looked up this question and finds that quite apart from oxygen solubility the presence of high concentrations of salt tend to slow down bacterial activity and thus reduce the rate of oxidation.

Mr. Manning said it did not follow from that answer that the rate of purification was slower in sea water than in fresh water, to which Mr. Calvert agreed, for there were so many factors entering into the problem. He believed that temperature was far more important than the rate of solution of oxygen. Further, in sea water there were more scavengers than in fresh water—lobsters, crabs, and so on, which did very valuable work—and fish life also helped in purification.

The President, commenting on the considerable difficulties involved in float tests, related an experience in connection with such tests in Milford Haven, South Wales, during the later years of the war, when the Air Ministry had had a certain control over the Milford Haven estuary. There had been considerable difficulty in obtaining the necessary permission to conduct the float tests; further, speed boats of the Air Ministry were continually racing up and down Milford Haven to ensure that there was no obstruction to aircraft landing or leaving. They had interfered with the float tests, by frequently running off with the floats. In those tests observations had been made with the aid of two or three theodolites located on land, records being taken of the movements of the floats down the estuary.

Again, one could never arrange with any certainty a predetermined programme for float tests, because wind conditions had a big influence on the tests; one had to fit in the tests according to the state of the tide, the state of the wind and weather conditions generally. That reference led him to recall Mr. Edward's question as to how far float tests should be carried, and he pointed out that the time spent on the tests was rather an important factor. On most occasions tests were very prolonged, and frequently one had to reduce the amount of float testing that one would normally advise an undertaking to make, because of changing weather conditions.

Finally, The President said that the paper and the discussion had been most interesting, and would prove of distinct value. Mr. Calvert's reference to the Rimrose Brook Joint Sewerage Board scheme would be of particular interest to the Institution's members in the North-West Centre, at Manchester, for a short time ago one of the members there had read a paper on some of the constructional details of the scheme.

Col. Temple (F.I.San.E.) wrote as follows: Mr. Calvert's paper seems to me admirable and I have no criticisms to make or questions to put to him; but there are points in it that remind me of instances in my own experience of the influence of the tides on drainage.

First, however, let me say that I have seen many tidal flaps and have hardly ever seen one shut. It may be that they go wrong out of perversity when I come along. Again and again, I have said to people showing me round sewage outfalls, " can that flap be much use? " and the familiar answer is " it has stuck (or something has jammed in it, etc.). It is not usually like that."

For 33 years, without being in any way responsible for it, except for some six months in 1911, when I was acting Head of the Public Health Engineering Department, in Bengal, I watched the results of the influence of the tides on the drainage of Calcutta. The town is some 10 miles long, on a strip more or less a mile wide, between the Hooghly on the west and low ground on the east. The slope of Calcutta is from west to east. Of all conditions that an engineer has to become accustomed to, one of the most difficult to grasp so that it makes the background of his thought, is that in alluvial plains subject to seasons of really heavy rainfall (people in England have little idea what heavy rain can be, 20 in. in 18 hours, and no idea what continued heavy rain is, 1 in. a day for five days topped up with 6 in. in 24 hours throughout a range of hills 100 miles long. The river taking the run-off rose 24-ft. in a night. I was upset in it and in a tree-top for three hours). The general slope of the ground is away from the rivers. This is because the rivers carry much silt when in flood and spill over their banks nearly every year, drop the silt on the banks, raising them higher and higher until the river is running in a groove in the embankment that it has made. When the ridge is high enough the river falls off to one side or the other and continues its land building process. The high bank of the Hooghly is typical. But it has been protected so flooding over it no longer happens. The main collecting sewers for Calcutta are north and south to a gravity outfall for part of the sewage and a pumping station for the rest, more or less in the middle on the east of the town. The district collectors run from west to east and east to west, being probably the only main sewers in the world deliberately designed to run both ways. About 1870, Clarke, with a sturdy indifference to convention, and with unusual vision, saw that if he made his collectors all the way from their summits in the high bank of the Hooghly to the same section as was necessary for storm water discharge at their outfall, all liquid lying above the highest point in the invert could run out backwards into the Hooghly whenever the tide was below that point. They have removed enormous volumes of storm water at the cost of no additional excavation and only of a little extra brickwork (cement concrete was then and for the next 30 years so little known in Calcutta that folk feared it as if it were high explosive) and the penstocks. I do not know if tidal flaps were ever tried. During my 33 years the penstocks were always worked by hand to be sure the tide did not come into the town.

Calcutta throws its sewage out of its back door. It threw it originally into the nearest of the channels which run roughly north to south through the delta. But that channel silted up. This was due to the lack of liaison, perhaps tempered by ignorance, between Government Departments, which so often causes one department to spoil the work of another. The natural channel was kept clear by enormous volumes of tidal spill which at every high tide spread over miles of country and at every low tide scoured the 130 or more miles of channel with sufficient velocity to remove all Calcutta sludge. The Canals Branch of the Public Works Department either ignoring or being ignorant of the fact that checking tidal spill always causes silting up of the channels downstream from the obstruction, built a canal running eastward from the city. This stopped the tidal spill and the channel immediately began to silt up. It was some years and much too late before the true cause was known. All sorts of palliative measures were tried including buying at great expense a special dredger. It dredged its way from the sea about 80 miles upstream and then had to dredge its way out again as the channel silted up as fast as it was dredged. When I was last in touch with what was happening, the Corporation of Calcutta was apparently determined to throw its sewage a little further out of its back door into the next live channel, where the addition of the sludge will very likely upset the balance and cause that channel to silt up in turn.

The right thing to do was and still is to compost the city's sludge with the city's refuse which is nearly all dumped near the outfall. The resultant more or less clarified liquid with the help of such tidal spill as is left, would always maintain a channel to the sea just sufficient for its needs.

Port Facilities at New York

A Comparison between British and American Methods

By AUSTIN J. TOBIN
Executive Director Port of New York Authority.

ALTHOUGH the Port of New York is commercially a single district, it is by no means a single waterfront nor a single waterway. Rather it is a conjunction of many harbours, a combination of several channels and in reality a port of many ports. Its dozen rivers, bays and straits provide water access to a total waterfront of 650 miles. Altogether, the Port District covers approximately 1,500 square miles of land and water area and embraces parts of two states, New York and New Jersey. It includes some 219 municipal and other minor civil divisions. As can well be expected in a port of this size and geographical make up, its problems are many and varied.

OWNERSHIP OF PORT FACILITIES

Unlike London or Liverpool where the Port Authority or the Dock Board furnishes the dock system, quays and transit sheds, in the port of New York these facilities are owned by various interests. The City of New York owns about 50% of the deep-sea ship wharves, the railroad companies about 5% and private dock companies and individual steamship lines about 35%. The Port Authority administers only the remaining 10%.

This division of ownership naturally acts as a deterrent when it comes to attempting to bring about an over-all port development and improvement programme. Even though the Port Authority was created by the States of New York and New Jersey in 1921 to carry on such a programme, the Port Compact provided that the property of the separate municipalities could not be incorporated into the programme of comprehensive port development without the consent of the municipality. The problem of securing co-operation from these varied interests and of persuading them, in the interest of the over-all development of the whole Port, to yield political control of their own section of the waterfront has been far from simple. In the 30 years of its existence the Port Authority, although it has accomplished many of the things for which it was created, has not as yet been able to bring about a co-ordinated and comprehensive development of the waterfront itself. In 1948, for example, the Port Authority undertook the study of and made a proposal for the rehabilitation, modernisation and new construction of the New York City-owned waterfront facilities. This $114,000,000 development programme was designed with the over-all port picture in mind. Together with our $14,000,000 development programme already under way at Port Newark and proposals for similar marine terminal developments at Hoboken and Jersey City totalling another $30,000,000. we felt that the carrying out of this programme would insure the continuance of New York's position as the world's leading port. Unfortunately, the City of New York declined our offer in favour of its own $58,000,000 improvement programme; a programme which, except for some fire prevention work which I shall mention later, has been practically abandoned.

So, too, the Port Authority's proposals for the reconstruction of that part of the Port's waterfront in the New Jersey municipalities of Hoboken and Jersey City, which were made in 1947 and 1949 and which involved the construction of modern pier facilities estimated at the time to cost a total of about $29,000,000, were also rejected by those two cities. It is interesting to note that neither Hoboken nor Jersey City have any other plans for the development of their waterfront and that their present facilities may be described as ranging from obsolete to non-existent.

CHARGES FOR PORT FACILITIES

Unlike the English ports, where, to take Liverpool as an example, about 75% of the Dock Board's income comes from harbour dues as against 25% for use of specific docks, landing stages, ground areas leased to the industry, graving docks, etc., our local port agencies may assess charges only for specific services or facilities. However, just as we have numerous owners of port facilities in New York, we have various methods of charging for these facilities. The City of New York, for example, leases most of its piers on a long-term basis to individual steamship lines for their exclusive use. Many of the private dock companies do likewise. The Port Authority at its Columbia Street Pier and at its wharves at Port Newark levies dockage and wharfage charges against the ships and their cargoes and does not restrict the use of its facilities to specific steamship lines. At Columbia Street we do assess an additional charge known as a berth preferential charge, the payment of which entitles a steamship line to the preferential but not exclusive use of a ship's berth. It is our intention thus to make available our facilities for maximum usage which is not possible under an individual lease basis.

With respect to the railroad-owned piers, the general practice is to make little or no charge against the deep-sea vessels using the facilities. As a result, it presents a serious competitive factor to an agency such as the Port Authority which is required to operate its facilities on a self-supporting basis. This practice is not confined to railroad-operated docks in New York but is also the case at Baltimore, Norfolk, Philadelphia and Boston ports where all or many of the dock facilities are controlled by the railroads and therefore creates an inter-port competitive factor as well. As this practice not only hurts other port terminal operators but the railroads themselves, who it is estimated by failure to make such charges lose between $5,000,000 and $10,000,000 annually, the North Atlantic Ports Association, of which the Port of New York Authority is a member, is currently endeavouring to convince the railroads to charge for their facilities.

CHANNEL DREDGING AND MAINTENANCE

In this respect port operators in the U.S.A. and, for that matter, vessel owners using the ports have an advantage over ports of the United Kingdom. Under the American system of Federal control of navigable waterways and of interstate and foreign commerce, the Federal Government assumes responsibility for dredging and maintaining the main harbour channels, lighthouses, buoys and anchorage areas and in turn collects ship dues. These dues, however, are nominal and by no means approach the cost of this work.

The Port Authority, in co-operation with other local maritime interests, campaigns vigorously for the improvement and development of channels in the Port District. We analyse many proposed channel modifications and present our views to the Federal Government with respect to the need for increased appropriations for channel projects in the New Jersey-New York Port District. It is unfortunate, however, that despite our efforts, less than 3% of the Federal funds for improving and deepening rivers and harbours has been allotted to channels in the Port of New York during the last four years when 40% of the total foreign trade of this country moves through our port. Nevertheless, we feel that our work has borne some fruit, for in the 1950-51 budget it was recommended that $6,250,000 be earmarked for the Port of New York as compared with $3,550,000 in the 1949-50 budget.

DOCK LABOUR PROBLEMS

With respect to the problem of insuring greater regularity of employment for dock workers and a more stable and dependable income, it must be admitted that labour employment practices at ports in the U.S.A. fall far short of providing the answer. We do not have, as is the case in England, under the recent Decasualisation Scheme, any guarantee of weekly income, not any method of adjusting in advance the number of men applying for jobs to the anticipated need of a port or, for that matter, even of a pier. This, of course, results in very imperfect adjustments to shifting the volume of employment from day to day, and in New York, has caused a more or less chronic over-supply of dock workers (it is estimated we have 42,000 union longshoremen competing for an average of 25,000 jobs daily) and highly fluctuating take-home pay.

Port Facilities at New York—continued

Furthermore, there is no registering of available dock workers, no screening of criminal records and no eligibility requirements except union membership. Most of the hiring is done from the morning and afternoon "shape" at the pier where the dock workers merely line up and are selected by the hiring bosses. Of course, this system invites favouritism and all sorts of kick-backs by the men in order to secure a lay's work.

Many of the port people in America have studied the Scheme as operated by the National Dock Labour Board in the United Kingdom and consider it to be a most mature approach toward

Heavy duty material handling equipment at Port Newark expedites unloading of vessel and speeds turn-around time for greater shipping efficiency.

meeting this problem. It is felt, however, that while this particular National Scheme may not necessarily be wholly applicable to conditions in the United States, where ports are widely distributed and operated under varied conditions, nevertheless the experience in England has valuable lessons for American ports. Perhaps some day port labour and management will agree on some joint system which will improve our situation.

LOADING SERVICE AT STEAMSHIP PIERS

In New York the loading of freight from the pier floor to the tailboard of trucks, including asisting the driver in stowing heavy pieces in the truck body or tiering packages to heights beyond his capacity, is performed by longshoremen known as public loaders. While these men are members of the longshoremen's union, for the most part they are not hired by the terminal operators and operate only under the loosest sort of management responsibility. In fact, for many years the loaders operated in the form of separate gangs for each pier or group of piers and were responsible only to a boss loader who extended his power over the rest of the group. There was no control as to the service offered, the rates charged, the right to work in the gang or the splitting up of the receipts.

The situation became so bad that finally the truckmen of the Port of New York, operating through the Motor Carrier Association of New York, worked out a code which is administered by the so-called Truck Loading Authority of the New York Trucking Industry. This is a wholly informal joint committee with representation from the trucking industry and the International Longshoremens' Association which publishes a rate schedule for each type of commodity and certain rules and regulations defining the responsibility of loaders and truckmen. It is not legally binding, and complaints of departures from these rates and rules are handled by a committee of the Motor Carrier Association. Interpretations of the code and disputed cases are rendered by an arbitrator.

Through this device, a rather limited machinery exists for handling complaints, dependent in a large part upon the personal co-operation of the many pier gang leaders in adjusting differences with the truckmen, under the spur of discussion and threat to boycott piers served by recalcitrants.

As the truckmen and consignees insist on the right to use public loaders at their option, reserving the right to use their own helpers, there are periodic flareups. Adherence to this principle obviously means that the employment of the loaders at a particular pier is more irregular than if the loading service on all incoming freight was performed by them. The loaders complain that large volume easily loaded packages are frequently handled by the truck drivers' helpers, leaving them, the loaders, with only the undesirable freight to handle. They, therefore, insist on handling all or nothing.

Another cause of trouble is the endeavour from time to time by the public loaders to require that discharge from the trucks to the pier floor be given to them. As this operation does not require the same extra manpower as does the truck loading, the truckman, in almost every instance, is able to perform the work himself and therefore views with alarm the attempt to introduce public loaders into this operation.

Still another basic point of controversy results from jurisdictional disputes, which frequently arise between union locals in respect to the right to load certain special types of commodities, such as newsprint, where understandings have been reached between employers and international unions, assigning the loading work to one local as against another.

There is no doubt that the loading of trucks is a necessary service and must be performed by someone. It would seem to be highly desirable that the terminal operators take the responsibility for providing this service under some system, perhaps similar to the Master Porter method adopted at a number of English ports. However, to date these operators deny the responsibility and we struggle along under a rather sorry sysem.

SHIP TURN-AROUND TIME

In this day of high terminal costs it is imperative that ship turn-around time be held to a minimum. In the Port of New York, we have perhaps been more fortunate than at other ports throughout the world.

Geography itself has been in our favour. Nearly 80% of the shedded steamship berths for general cargo shipments are located on the island or New York side of our harbour. On the other hand, almost all the terminals of the railroads serving the Port are located on the continental or New Jersey side. This has resulted in the building up by the railroads of a fleet of over 2,500 tugboats, barges, lighters and carfloats to effect the speedy movement of their rail freight to shipside throughout the port. No charge is made by the railroads for this lighterage service and nearly 50% of our import-export cargo moves to or from our piers in this manner. In turn, the ship owners consider the lighterage system an important factor in ship turn-around time. As it permits the simultaneous loading or unloading of vessels from or to both dock and offshore, the vessel time spent in port is minimised.

This system together with extensive use of mechanised materials handling equipment, enables us to achieve approximately the same efficiency as we had prior to the war.

However, we do not feel that we should rest on our oars. To the average cargo vessel operator every day in port means about $3,000 when the wages and food for the crew and the overheads in the form of insurance, depreciation and interest on investment are taken into consideration. If we are to maintain the Port of New York's prominent position in world trade, we feel that steps should be taken to modernise our facilities so that delay time of a ship in port can be further reduced.

Our waterfront facilities are composed almost entirely of finger piers as compared with the English system of quays. It is probably true that the latter system is more efficient for loading and unloading vessels but primarily due to the high land value in our port, as well as the availability of wide rivers into which we could extend our piers, our system was developed so as to give us the maximum number of berths per lineal foot of shoreline utilised. Unfortunately, the majority of our piers are quite old and were built to accommodate much smaller ships than those using the port to-day. Most of them are less than 100-ft.

Port Facilities at New York—continued

wide and even the newest facilities in the harbour are only 150-ft. wide.

Modern ships have a cargo capacity and a loading and discharging rate which would permit much faster turn-around were the piers able to receive and dispatch their inward cargoes or to assemble and unload their outward cargoes more rapidly. The size of most of our piers in New York harbour does not permit this.

Adding to this problem in recent years, has been the increase in the amount of cargo moving to and from our piers by motor truck. To-day nearly 40% of all import-export freight moving through New York comes to or goes away from the piers in motor vehicles ranging in length up to 40-ft. One can imagine the task it is to take such a truck on to a pier only 50-ft. or 60-ft. wide, load or unload it and turn it around to get it out again, and to do this with a pier about two-thirds occupied by cargo.

At the Port Authority, we believe that in order to provide sufficient cargo space for the larger vessel loads now moving through our port and to allow the large over-the-road trucks to enter, load or unload and depart without interfering with the loading and unloading of vessels, 90,000 square feet of shedded space should be provided for each ship's berth. Incidentally, our conclusions in this respect have been corroborated by the plans for some of the newer cargo piers, which are under construction or have been completed, at such diverse locations as Norfolk, Boston, Long Beach (California) and Honolulu. Normally, this would mean that the pier should be from 250-ft. to 300-ft. wide. Our plans for new construction call for such piers in New York City, Jersey City, Hoboken and Newark, but it can be seen what a tremendous task confronts us when we speak of modernising our port.

The problem of congestion caused by the trucks is in reality two sided, since it not only costs the steamship operator money through loss of cargo loading and discharging efficiency, but, we estimate, also costs shippers and consigners approximately $8,750,000 annually through truck delay time for which they are charged.

The increased size of piers would help, but in our plans it soon became apparent to us that the problem of highway approach to the piers must also be solved. On the Island of Manhattan, not much can be done in this respect, for the marginal way or street running along behind the inshore end of our piers is, in most cases, only 50-ft. wide. This area is used for truck unloading, stacking of certain cargoes, truck waiting lines as well as running traffic. The resultant congestion can well be imagined. However, as most of our piers have bulkhead sheds averaging about 50-ft. deep built inshore from the bulkhead, there is the possibility of securing an additional 50-ft. for this marginal street by building, in the case of new piers, the bulkhead sheds from the bulkhead outshore rather than inshore. This we proposed to do in our plans for new piers but, of course, it would not be practical, nor is it required, that all piers on Manhattan be replaced, so that this proposal does not entirely answer the question. However, in the case of those existing piers which should remain, we advocate the installation of doors along the bulkhead shed so that trucks can back into the shed off the marginal street in order to perform their loading or unloading.

In our plans for a marine terminal development at Jersey City, we found that while we had ample room along the waterfront for a modern two-pier general cargo facility, the supporting upland area was a highly industrialised centre, with very narrow and extremely congested streets. As the waterfront under study in Jersey City is presently utilised to little extent for general cargo activities, the creation of four deep-sea berths would result in a tremendous increase in the amount of truck traffic moving through the area. As a result, we considered it necessary that an entirely new highway which would circumvent the industrial area should be built. While this adds substantially to the cost of the proposed terminal, in the long run it is certain to be a worthwhile public investment.

At Hoboken, we were faced with the necessity of designing a double-deck general cargo pier due to the shortage of shoreline available. However, a second deck without direct truck access is considered by operators in our port as being only about 50% efficient. We, therefore, included in our plan two ramps running from the upland into the second deck by which trucks would have the required access.

MECHANISATION

I mentioned briefly the fact that our cargo handling methods on the piers are almost completely mechanised to-day. The question may well be asked as to whether or not we have found that this mechanisation pays for itself. To this I can answer that it is the unanimous opinion of pier operators in New York Harbour that without the modern materials handling machines, primarily the fork lift truck and pallet system, our labour efficiency would be far below the pre-war level. With the machines, we are now loading and discharging vessels at approximately the same overall average rate, 1 ton per man hour or 20 tons per gang hour, as was done before the war. We have not been able to replace men with machines since under present day collective bargaining contracts, this is not possible. Our stevedore gang, 20 men, is rather an inflexible institution. Whether we use machines or not, we must employ the same number of men. The machines, therefore, can merely enable a man to produce with less effort. As labour has become accustomed to, and in fact expects to, be supplied with these machines, it is undoubtedly true that without them we would not be able to handle the volume of cargo which we are handling to-day.

While on this subject, I should like to comment briefly on the advisability of using dock cranes for cargo handling. It seems

Air view of one of two new Cargo Terminals built at a cost of $2,500,000 at Port Newark: features wide loading apron with flush rail tracks, central truck roadway entrance, and, at rear, a rail and truck loading platform.

that every visitor who comes to our port is surprised to see that we have no cranes on our piers. They all seem certain that we are missing a good bet. However, after we explain that practically all of our piers are leased on a long-term basis to an individual steamship operator, who on the average uses his pier less than 50% of the time, they can see that it is unlikely that the cranes would pay for themselves. In addition, due to our finger type of construction, we would not be able to move the cranes from one berth to another. Finally, our stevedores and most of the vessel operators using the port feel that the efficiency we attain through the use of ship's gear is at least equivalent to that of the dock cranes.

FIRE PROTECTION

One of New York's most serious problems is the lack of adequate protection against fire on our New York piers. Between May of 1932 and June of 1947, there were 11 major waterfront fires with severe damage or total destruction of pier properties in New York Harbour. The property destruction in connection with these fires is estimated at upwards of $15,000,000 in structure and contents, and the death toll was 34 persons.

Practically all of our piers are built on timber piles and hardly any are equipped with under-deck sprinkler systems, likewise,

Port Facilities at New York—continued

very few of our pier sheds are equipped with sprinklers. This, of course, means that once a fire breaks out on a pier, particularly under-deck, it is extremely difficult to combat. As a result, the cost of fire insurance in the Port of New York is extremely high, running approximately $1.81 per $100 of valuation per annum. This factor alone has sometimes resulted in the loss of trade to our port.

Contained in our proposal to the City of New York, which I mentioned before, was an offer to spend over $5,000,000 to install necessary protective devices on all piers which we anticipated to have a life of ten years or more. These devices included dry pipe sprinkler and sandpipe systems in the pier sheds, fire resistor walls at 140-ft. intervals in the sub-structure under the deck provided with dry pipe sprinklers on both sides, nozzle openings in the deck at 25-ft. centres, to allow use of fire nozzles for fighting under-deck fires, non-combustible truss curtains at 100-ft. intervals between the bottom chords of the roof trusses and the roof itself to accelerate action of the sprinkler heads and prevent mushrooming of hot gases and flames, together with fire alarm and watchmen alarm systems. It was estimated that through the installation of all these devices, the annual premium rate for insurance would be reduced from the $1.81 to about 46c per $100 of valuation.

I am happy that I can say that although the City of New York turned down our proposal in favour of their own, they have made their best, in fact their only real progress, in the installation of these fire protection devices and have spent nearly $2,230,000 on this work within the last year and a half.

The Port Authority has installed such devices at all the waterfront facilities it inherited and has included them in all of its new construction.

Of course, where sheds are built on solid fill without piles, such as they are in many English ports, there is no under-deck fire hazard; in New York, however, this is a very real problem.

PORT PROMOTION AND PROTECTION

In the United States there is a constant competition among the various ports for import-export trade. In recent years particularly, the East Coast and Gulf ports have been able to increase their business, even though New York has been able to hold its own. While there is no doubt that our port offers importers and exporters many shipping advantages over competitive ports, it is necessary that they be kept constantly aware of these advantages. As one of the duties assigned to the Port Authority when it was created, we carry on a comprehensive programme to publicise such information. Our Port Promotion Bureau through its offices in New York, Chicago, Cleveland and Washington does much to attract commerce to New York.

In addition, we are constantly on the lookout to prevent discriminatory rate rigging, which would result in advantages to other ports on freight moving to and from them by rail as well as water.

Our Traffic Bureau surveys rates, regulations and practices of all modes of transportation, serving the New York Port area as well as competitive ports along the Atlantic and Gulf coasts, and appears before the Interstate Commerce Commission on rail matters and the Maritime Board on water matters to argue New York's position and protect our port's interests.

THE PORT AUTHORITY

In my opening paragraphs I spoke of the over-all work of the Port of New York Authority, in addition to the construction of docks and pier facilities.

The Port Authority was created in 1921 under the terms of a Treaty between the States of New York and New Jersey to go forward with the planning and development of public terminal and transportation facilities for the whole area surrounding the Port of New York and for the development and protection of its commerce. Its organisation and procedures are similar in many respects to those of the Port of London Authority and the Mersey Docks and Harbour Board. Over the period of the past 30 years it has financed and constructed, on the basis of its own credit, without tax support, almost $400,000,000 worth of public terminal and transportation facilities.

The Authority's Lincoln and Holland Tunnels and George Washington Bridge spanning the Hudson River, and its Bayonne and Goethals Bridges and Outerbridge Crossing connecting Staten Island and New Jersey, join the States into one vast industrial, residential and recreational area.

The bi-state agency's terminal facilities include the Port Authority Building, housing the Union Railroad Freight Terminal, the New York Union Motor Truck Terminal and the Port Authority Bus Terminal in Manhattan; the Port Authority Grain Terminal at Gowanus Bay, Brooklyn; La Guardia Airport and New York International Airport in New York City; Newark Airport, Teterboro Airport, Port Newark and the Newark Union Motor Truck Terminal in New Jersey.

Charged by statute with the protection of port commerce, the Port Authority appears before such regulatory bodies of the Interstate Commerce Commission, the Civil Aeronautics Board and the Federal Maritime Board in the interest of the welfare of the unified Port Area. It maintains branch offices in Washington, Chicago and Cleveland in the interest of promoting the movement of commerce through the Port of New York.

The Port Authority Grain Terminal and piers, built by the State of New York and opened in August, 1922, as part of the New York State Barge Canal System, was transferred by the State to The Port of New York Authority in May, 1944. The terminal is located at the foot of Columbia Street in the Gowanus Bay section of the Brooklyn waterfront.

The terminal includes a grain elevator, a new grain pier and gallery constructed by the Port Authority, the Columbia Street Pier and a public open storage area. Since 1944, the Authority has completely rehabilitated the elevator, piers and upland area.

The Port Authority Grain Elevator is the most modern facility in New York Harbour for the storage of grain and is the only one equipped with an electric thermometer system in the storage bins. It has a storage capacity of 1,800,000 bushels of grain. The new grain gallery has been constructed on a new pier to permit the loading of grain direct from the elevator to deep-sea ships alongside the grain pier. Within the structure of the grain gallery itself, two 3½-ft. wide moving belts carry grain from the elevator to spouts which funnel the grain directly into ships' holds.

The Columbia Street Pier has 30-ft. to 35-ft. water depth alongside and will accommodate four deep-sea vessels simultaneously. Operated by the Port Authority, the pier is used by two steamship companies, one on each side of the pier, under a preferential but non-exclusive permit system which permits the assignment of outside vessels for berthing in the event the permittee lines do not schedule their own vessels for periods of more than fourteen days.

Port Newark is operated by The Port of New York Authority under a 50-year lease agreement with the City of Newark, effective March 22, 1948. Located on Newark Bay, Port Newark is 8½ miles by truck route from the New York end of the Holland Tunnel and about 3½ miles from the centre of Newark. It is adjacent to Newark Airport and within one mile of the Port Authority's Newark Union Motor Truck Terminal.

Port Newark is reached from the open sea, either by way of the Narrows and Kill Van Kull to Newark Bay or by way of the Arthur Kill channel between Staten Island and the New Jersey mainland to Newark Bay. The ship distance from the Narrows to Port Newark is eight miles, the same as to Manhattan's North River Chelsea piers.

Under the Port Authority's programme, a total of $14,000,000 will be spent for improvements and property acquisition at the marine terminal, of which over $7,000,000 has been spent or committed. When the improvement programme is completed, this New Jersey port will be one of the most modern marine terminals in the Port of New York, with rehabilitated wharves and buildings, four new large transit cargo sheds, and depth of channel to accommodate the largest freight carrying vessels. Direct ship-to-rail transfer facilities and adequate buildings and land for public storage purposes are among the important features offered at Port Newark. Waterborne tonnage through Port Newark during 1950 will total over 1,600,000 tons.

Port Newark is within the free lighterage limits of the Port of New York District and is served directly by the Central Railroad of New Jersey, the Lehigh Valley Railroad and the Pennsylvania Railroad. The lighterage service of all the major railroads serving New York gives Port Newark a full cargo interchange service.

Cranes, Ship's Derricks and Quay Lay-out

In connection with articles and correspondence on the above subjects, which have appeared in this Journal during the past year, the following additional letters will be of interest.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

QUAY LAY-OUT IN GENERAL CARGO HARBOURS

In the January, 1950, issue of *The Dock and Harbour Authority*, Mr. Herman Jansson, Chief Engineer, Stockholm Harbour Board, has published an article on " Quay lay-out, problems concerning sheds, equipment and transport of cargo." It is always a pleasure to read Mr. Jansson's articles, and in this particular one a series of current harbour problems is treated in a theoretical way which is most inciting.

The comparative experiments proposed by Mr. Jansson—experiments which so far as I know are in course in Sweden at present—must be looked forward to with great interest by all who are engaged in such problems, but the conclusions are probably not transferable to other countries, maybe not even from one Swedish port to the other.

In Denmark conditions are in many regards similar to those in Sweden, and to a great extent the same ships call at Swedish and Danish ports. The character of the imports to the two countries is presumably not very different either. But nevertheless conditions are quite a bit different. Denmark is a country consisting of many islands and peninsulas, and consequently all parts of the country are situated near one of its numerous ports. The railway traffic is of comparatively small importance, as most of the goods are shipped seawards from one port to the other, and the rather short land transports are extensively taken care of by motor-lorries. Consequently one or two railway tracks alongside the edge of the quay and one track behind the warehouses will as a rule be sufficient; at intervals, however, shunts and crossovers are necessary. It is therefore obvious that comparatively narrow aprons with a width of about 15 metres will do. This means that quay cranes need a maximum radius of reach of 20 metres only, a type of crane which is handy as well as fast working. On the other hand it is impossible to serve a lighter moored at ship's outer side with this radius of reach, but the lighter traffic is rather small in Denmark and when cranes handle the goods from ship to quay, the ship's derricks are free to unload to lighters at the same time if required.

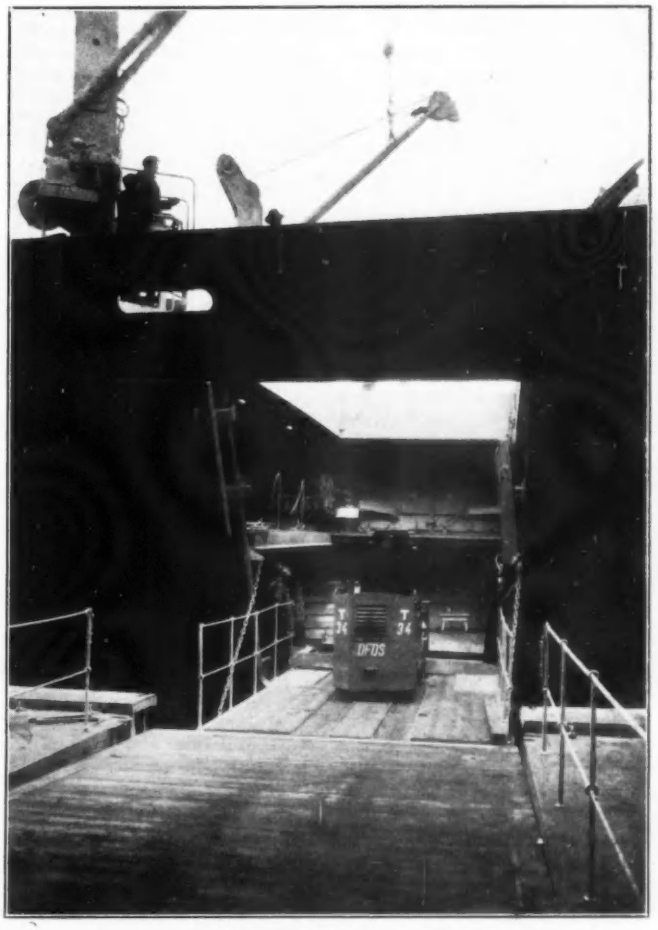
It has been discussed whether three or five tons cranes or a combination of both would be most advantageous in Copenhagen, but finally 3 tons cranes have been found most suitable because very few loads demand bigger lifting capacity and such loads can always be handled by the ship's derricks.

Direct unloading from ship to truck does not seem very much desired. Imports are usually mixed together, and a sorting has to take place either on the apron or in the shed to make distribution to the receivers possible. Exports are easier to load directly from lorry to ship, but on the other hand this procedure often creates a formation of long queues, which means unproductive waiting time for the vehicles and jammed-up traffic besides. It is therefore preferred to have the cargo arrive immediately before loading is to commence. With fork-lifts and mobile cranes and perhaps also available quay-cranes the goods are taken from the lorries and piled according to destination on pallets or in containers. This method allows the ship's officer in charge a much better survey of the goods, and stowage according to the character of the goods and to the destination can be arranged in the most practical way.

In Copenhagen the general cargo can be divided into three main groups :

(1) Trans-oceanic general cargo carried by big ocean-going vessels. These ships demand great depths of water (9 to 10 metres), big sheds, and wide aprons, and they are mainly handled in the Free Port. Even though many of these ships are cargo liners, they call at so many ports that the ships cannot be given special equipment adequate for every port. The cargoes consist mostly of imports in boxes, barrels, and bales, and large quantities have to be stored under cover.

(2) European general cargo in middle-sized vessels. A depth of water of seven or eight metres is sufficient. This category includes imports as well as exports. In this case vessels with special gear cannot be expected either. The character of the cargo is generally more uniform than that of the trans-ocean traffic, as especially the imports to a great extent consist of dimensive articles, such as iron pipes, steel beams, and sheet-iron, which do not have to be stored under cover.



Port of Copenhagen. Photograph showing goods being driven direct on board through ship's side port.

(3) Inland general cargo in small vessels which only require a depth of water of five or six metres. The quantities of imports and exports more or less balance. The cargoes consist of a variety of different goods, but cargoes divided in small packages, however, are predominant. Almost all ships are liners in regular service, thus permitting special equipment to be installed in the vessels as well as ashore. No railway tracks are required on the apron.

It will be seen that rather different demands are made of the quay lay-out for these three kinds if traffic, and consequently there are special quays for every group. As to the first group which requires a quay lay-out similar to the quays mentioned in Mr. Jansson's article, quays with cranes and warehouses of several storeys as well as quays without cranes, but with sheds of one or two floors, are in use in Copenhagen. It is difficult to decide which type of quay lay-out is theoretically the most advantageous, because no considerable difference in turn-around or in loading expenses has been experienced. However, as extension of the quayage in the Port of Copenhagen is undesirable, the efficiency of the quays must be increased either by building warehouses with more floors which automatically necessitates installation of quay-cranes, or by building supplementary sheds behind the quay-sheds and employing a large quantity of trucks and trailers for

Cranes, Ship's Derricks and Quay Lay-out—continued

transport between apron and sheds. As only a few areas are available in the second line it will in most cases be necessary to use the first mentioned improvement.

For traffic of the second category the same conditions are prevailing. The warehouse-area required is comparatively smaller as the goods are generally stored only a short time in the harbour area.

As regards the third kind of traffic progress is showing in a different way. A strong tendency to equip special ships with side ports or special cranes has developed. The great variety of goods is mainly transported on pallets or in containers and brought to the ship's side by fork-lifts or cranes. If the ships have side ports the goods are taken directly on board as shown in the photograph. " The United Steamship Co.," for instance, has achieved satisfactory results with such mechanical handling, but it will, however, lead too far to treat this subject in this article.

Yours faithfully,

Port of Copenhagen,
December, 1950.

J. C. RODE,
Chief Engineer.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

QUAY LAYOUT PROBLEMS

The paper on " Quay Layout " by Herman Jansson, which was published in the January, 1950, issue of " The Dock and Harbour Authority," and the relevant articles and correspondence which have appeared since, and been studied with interest.

These contributions contain much helpful information on the fundamental spacings and clearances required for modern cargo quays, and among other points of interest suggests the possibility, in suitable cases, of dispensing with dock cranes by developing a system of using ships' derricks and modern mobile truck transport.

Consideration of the two methods (cranes or ships' derricks) would be largely influenced by a comparison between the capacity of modern level-luffing cranes and modern ships' derricks to transfer cargo between the ships' holds and the quay-side.

It would therefore be extremely useful if we could have statistical figures; covering (a) the average turn-round time of a dock crane operation, (b) the effect on the turn-round time of increasing the radius of operation of the crane, (c) the average tonnage per hour handled by dock cranes of different capacities, and (d) the comparable tonnage per hour figures for ships' derrick working, and we would be grateful for any such information that may be available.

Yours faithfully,

Victoria Street,
London, S.W.1.
November, 1950.

CONSULTING ENGINEER.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

PORT TERMINAL OPERATION

With reference to the articles entitled " Quay Layout " and " Port Terminal Design and Operation," which appeared in the January and March, 1950, issues of your Journal, and more particularly, with regard to the relative use and efficiency of quay cranes and ships' derricks, the following information may be of interest.

The Port of Tacoma's quay cranes are all of the straight line type (not luffing boom), with the exception of one heavy-lift crane of 60-ton capacity that is only used for heavy lift operations from and to ship's holds, which, as you know, is a slow operation not predicated upon speed.

We have not kept a record from the standpoint of monetary savings between the operation of quay cranes and ship's derricks, but we do use our cranes practically all the time in handling bulk commodities from ships' holds to open-top railway cars such as bulk ores and sand, and in this operation, using electrically operated grab buckets, the saving with the use of the cranes against ship's derricks amounts to a minimum of 25%.

We also use our cranes in place of ship's derricks in handling quantity cargoes of one material, such as wool, box shooks, and other commodities of one class, where the tonnage is sufficiently large to warrant the use of the cranes. In this sort of an operation our saving over ship's derricks amounts to a minium of 15% in time.

We do not find that quay cranes are preferable to ship's derricks when discharging or loading small or mixed lots of general cargo, as the time involved in assembling and sorting overshadows the saving in time in crane operations. The best operation we have found for this class of cargo is ship's derricks, cargo boards, and gasoline-operated fork lift trucks.

We are not able to give any information as to whether or not the luffing boom type of quay crane is an advantage over ship's derricks but from watching operations of this character, our opinion is that, as a rule, ship's derricks are as fast as the luffing boom cranes, due primarily to their revolving and luffing movements, which are eliminated in the straight line type of crane.

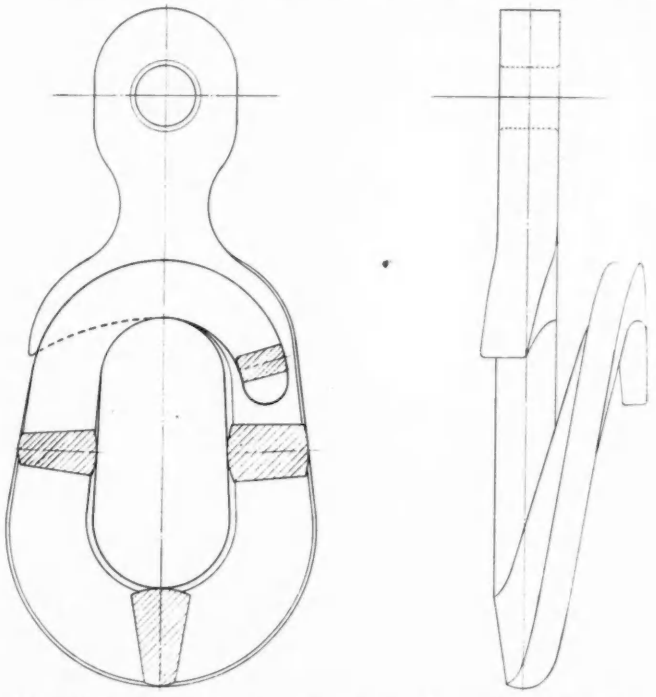
Yours very truly,

Port of Tacoma,
Washington, U.S.A.
15th January, 1951.

G. W. OSGOOD,
Manager and Chief Engineer.

New Type of Crane Hook

A new type of safety crane hook has been produced by the River Wear Commissioners. The hook was devised by Mr. Harry Wilson, Foreman Blacksmith, and has been patented. The need for it arose from the fact that considerable trouble had been experienced in the past in unloading certain bulk cargoes, for example, iron ore, owing to the tubs landing upon uneven surfaces and tending to become unhooked, with consequent danger to men working on the cargo. The new hook has been used experimentally with great success; it has been impossible to cause a tub to come off the hook, while at the same time it is easy to manipulate and simpler to hook on to a tub than the old type.



The Hook is shown for a safe working load of 3 tons. The dimensions will vary with the safe working load required and will follow the appropriate British Standard Specification so far as it is applicable.

No arrangements have been made for manufacturing the hook, but if there is likely to be a demand, this will be done.

Developments in Harbour Radar

Introduction of New Equipment of Advanced Design

Since the end of the second World War, the possibility of using shore-based radar to assist the safe navigation of ships in coastal and harbour waters has received much attention in " The Dock & Harbour Authority ", and several articles have been published concerning a number of interesting installations which have been carried out in this country. The subject has created considerable interest among port authorities throughout the world, many of whom are now considering various means by which harbour radar may be applied to solve their own particular problems.

The requirements of radar for port supervision are even more stringent than those for ship-borne equipment, as the radar screen must present a picture of the harbour with the maximum possible definition and clarity. The accuracy with which targets are separated in both range and bearing should be several times better than that required for normal ship-borne use, and there must be a complete absence of side lobe interference which tends to confuse the radar picture of a congested waterway. These and other important requirements make it necessary that a harbour radar system should be of very high quality.

Up to the present, one of the principal impediments to progress in harbour radar has been the high initial cost of the equipment, which, if an extensive harbour plan is to be effectively carried out, might be as much as £100,000. With these factors in mind, Decca Radar Ltd. have, for some months past, been engaged on a programme of research and development to produce a harbour radar equipment which will provide a picture of the very highest quality, at a cost which is considerably lower than was previously possible. This research has proved entirely successful, as was shown at a recent demonstration at Southampton.

DESCRIPTION OF EQUIPMENT

A shore based radar employed for harbour supervision or waterway control should possess the following principal features:—

(1) **High Bearing Discrimination.**—The horizontal beam produced by the scanner should be narrow.

(2) **High Bearing Accuracy.**—A sharp beam combined with accurate transmission of bearing information to the display.

(3) **Minimum Side Lobes.**—For use in harbour areas, the side lobes of the scanner must be very small to prevent obscuring of the radar picture.

(4) **High Range Discrimination.**—A very short pulse of radar energy must be employed to ensure adequate separation of objects in line and to provide a sharp picture.

(5) **High Range Accuracy.**—The time base must be very linear and the range indication precise to ensure accurate measurement of range.

(6) **Ease of Viewing and Picture Interpretation.**—A very large scale display must be employed.

(7) **Continuous Operation.**—The equipment must be capable of continuous operation in all conditions of weather and climate.

Before starting research on the Decca Harbour Radar, a special study was made of these requirements, and the equipment finally developed embraces all the essential features. The equipment consists of a radar scanner (Fig. 1), of unusual design, technically known as a " half cheese ". This scanner is nearly 10-ft. across and produces a radar beam of .7 of a degree. At the same time,

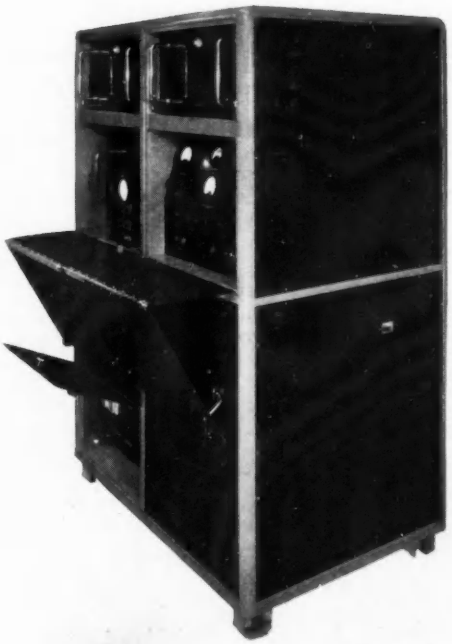


Fig. 1 (above). The Aerial and Radio Frequency Assembly weighs some 15 cwts. and is 8-ft. 6-in. from the base of the pedestal to the top of the " half cheese " aerial. This view shows one of the Radio Frequency Unit doors open. Each unit plugs directly in position and is easily removed for inspection. The 9-ft. by 7½-in. Scanner aperture is clearly shown here.

Fig. 2 (left). The Control Cabinet shown under operating conditions. The upper front panels are hinged and fold downwards to form the shelf shown. The hinged and fixed panels at the front and sides all remove for servicing.

Fig 3 (right). The Display Console. The switches visible at the left and right of the display panel are for the Calibrator and the Range Marker. On the raised centre panel containing the Range Indicator are, left, the Range Marker Control and, right the Range Switch. The Bearing Cursor Control is on the panel surrounding the cathode-ray tube.

Developments in Harbour Radar—continued

the side lobes produced by the scanner are extremely small. The scanner is mounted on a pedestal and is rotated by a motor drive within the base of the pedestal at 22 r.p.m. Immediately below the scanner is a weatherproof housing which contains two complete radar transmitters. Either transmitter can be selected for operation by push-button control from the radar control cabinet. The aerial, scanner and pedestal are so designed that they can be mounted on any convenient harbour structure, such as the roof of a harbour office or at the end of a pier.

The radar information derived from the scanner is fed, via a control cabinet (Fig. 2), to a large 15-in. display console (Fig. 3). This console can be up to 1,000 yards from the scanner and therefore can be conveniently sited to meet the operational requirements of the port. The control cabinet contains power units in duplicate and various control circuits. It is designed to feed up to three display units simultaneously.

With such an equipment installed in a port, the radar picture presented on the 15-in. tube is of exceptional definition. For the first time with radar, this new equipment makes it possible to estimate the type of target that is being viewed. Buoys are shown as small pin heads of light. Small ships can be clearly separated from buoys, and the characteristic comet-like tail behind the target immediately reveals that it is moving and clearly shows the course it is steering. On a large target, such as a two or three thousand ton ship, it is even possible to distinguish between the bow and stern of the vessel. The radar picture of a busy harbour clearly shows the relative movement of all shipping threading its way up and down the channel. These notable achievements are the result of the combination of a very narrow transmitted beam of 0.70° with a pulse length of 0.06 microseconds, which have been achieved for the first time.

Another outstanding feature in the construction is the unit principle, which allows exceptional facilities for servicing. The equipment also is designed in such a way that, while a small harbour can be equipped with one single installation, larger harbours can use the same units multiplied to meet their operational requirement.

An entirely new development of great interest and possibility associated with the new model is the invention of a radio link by which the radar picture can be transmitted to any remote point. By this means, the picture obtained by the scanner may be transmitted to a display unit several miles away. This equipment is now nearing completion and will be working in conjunction with the present harbour equipment in the early spring.

There is little doubt that the introduction of Decca Harbour Radar will further encourage the active consideration of these valuable port supervision facilities for installation at ports throughout the world, and the new equipment, incorporating as it does the most modern techniques, will represent an important factor in Britain's overseas trade.

British Canals and Inland Waterways

Acceleration and Improvement of Inland Water Transport and the Limitations of the Narrow Canal*

By C. M. MARSH, B.Sc., M.I.C.E., M.Inst.T.
(Divisional Waterways Officer, Docks & Inland Waterways Executive, North Western Division).

In considering the problems contained in this paper, the writer is deeply conscious that the problems of the inland waterways of England are widely different in detail from those experienced on the Continent of Europe or in the United States of America and Canada, the differences being mainly attributable to the short distance covered by an individual movement in this country and to the steep gradients encountered on most of the artificial canals of an arterial nature. These inherent characteristics of the English canal system may, however, be very helpful in the consideration of the problems involved, since the miniature scale necessarily accentuates the presence of any defects and the intensity of their occurrence merits every attention being given to overcome them and to encourage the acceleration of water transport.

The canal system in England—as elsewhere—contains two distinct types of waterway:—

(1) Natural rivers, canalised;
(2) Artificial canals.

The canalised rivers, with their natural sources of water supplied by direct drainage from their catchment area, have advantages over the artificial canals, which those responsible for their control have fully developed so that the barges navigating these waterways are in size and capacity larger than those navigating the artificial canals, excepting only the artificial ship canals to Manchester and to Gloucester.

The following table gives particulars of the canalised rivers. of the sizes of craft using them, and of the distances inland from the estuary:—

River	Barge	Inland Town	Distance	Estuary
Weaver	450 tons	Winsford	20 miles	Mersey
Severn	330 tons	Worcester	47 miles	Severn
Severn	180 tons	Stourport	60 miles	Severn
Aire	250 tons	Leeds	34 miles	Humber
Trent	250 tons	Newark	58 miles	Humber
Trent	140 tons	Nottingham	81 miles	Humber
Thames	60 tons	Reading	74 miles	Thames

* A Paper presented at the International Navigation Congress, 1949, in respect to Section I, Question I, "Acceleration of Transport on Inland Navigable Waterways." Reproduced by permission.

Brief characteristics of these canalised rivers are:—

(1) Downstream traffic moves faster than upstream traffic by reason of the natural flow;
(2) Locks are spaced at fairly wide intervals to overcome the natural gradient;
(3) After heavy rainfall or snow they are subject to floods;
(4) Adequate weirs and/or sluices have to be provided at each lock, to pass flood water;
(5) Bridges are few and far apart; while often low, they generally have openings of ample width to permit the free passage of floods;
(6) Ice causes very little interference with traffic;
(7) Fog is somewhat prevalent at certain seasons.

The artificial canals, generally dependent on artificial storage reservoirs for the supplies of their water, have been very little developed in size since they were first constructed in the period 1770 to 1830. In the northern part of the country, where there were perhaps better natural facilities for water supply, the canals are navigable by vessels up to 17-ft. 6-in. beam, while south of a line roughly joining the mouth of the Humber to the Mersey, the artificial canals are mainly navigable only by boats of 7-ft. beam.

The present position in regard to the waterways of England is that round the perimeter there are broad canalised rivers and broad artificial canals well developed for navigation serving the main estuaries and offering facilities for direct overside loading to and from ocean going steamer at Liverpool, Birkenhead and Manchester on the Mersey, at Goole and Hull in the Humber area, at Bristol, Avonmouth and Sharpness on the Severn and at London on the Thames; in the Midlands the manufacturing areas of Staffordshire and Warwickshire are served solely by narrow boat canals with boats of 7-ft. beam; such boats with their small carrying capacity are being found more and more uneconomic to operate and as they are unsuitable for estuarial navigation they cannot work direct to the major ports (the only exceptions being London and the inland port of Manchester). The manufacturing areas of the Midlands based on Birmingham are therefore deprived of direct water access to and from seagoing vessels; transhipment to and from estuarial barge at an up-river port is the only solution to-day, and this necessarily introduces delay to the movement of traffic and increases the cost of transport.

In an attempt to overcome this grave handicap on inland water transport between the Midlands and the major ports, the Ministry of War Transport during the 1939-45 war initiated three measures,

British Canals and Inland Waterways—continued

the general purpose of each being to consider, inter alia, measures for accelerating water transport through improved methods of construction and operation of navigable waterways.

These three measures were:—

1. The appointment of a special committee, consisting of three commercial and of three technical representatives drawn from the canal undertakings and from the canal carriers, under the chairmanship of the Deputy Director of Canals of the Ministry of War Transports.

One object of this committee was to determine the ideal size and dimensions of a barge which would enable goods to be transported by water without transhipment between ocean-going vessels in the major ports and the manufacturing area of the Midlands.

2. The appointment of a committee of eight engineers drawn from the various canals of the country, artificial waterways and canalised rivers both being represented thereon.

The object of this committee was to provide facilities for the interchange of information concerning the engineering features and the engineering practice on the various waterways with particular reference to:—

(i) Measures of accelerating transport by improvements in the type and operation of dredging plant.

(ii) The ideal dimensions of a waterway suitable for navigation by a craft of the dimensions recommended by the special committee (referred to in (1) above).

3. The investigation and preliminary survey of routes between the Midlands and the estuaries of the North West (Mersey), North East (Humber), South West (Severn) and South East (Thames) for development to a size suitable for navigation by craft of the dimensions recommended by the special committee (referred to in (1) above), the waterway having the dimensions recommended by the engineering committee (referred to in (2) above).

The writer was privileged to participate in each of the three measures mentioned; in the first as a technical member of the committee; in the second as a member and later chairman of the committee; in the third as responsible for the investigation and survey of the potential waterway from the Mersey to the Midlands.

This preamble suffices to give a general picture of the inland waterways of England as at present constituted with the two principal types of artificial canals (broad and narrow) of canalised rivers, together with a reference to the potential developments of arterial waterways connecting the Midlands to the major ports of the four estuaries. The following remarks will be directed towards the measures to be taken for accelerating transport on the inland waterways, with particular reference to the points which emerged from the deliberations of the two committees and from the surveys and investigations undertaken for the potential arterial waterways to the Midlands.

TRANSPORT UNIT

A ready test of the efficiency of transport may be obtained by a comparison of the relative distances that weights can be transported for the same cost.

Taking as a basic cost the hourly earnings of a transport worker, it is necessary to consider for each form of transport the average tonnage carried and the average distance moved in one hour and to relate these factors to the individual transport worker. This analysis for purpose of comparison may be termed the Transport Unit.

When man depended on the strength of his own limbs for transport, one man might carry 0.04 tons (90 lbs.) for a short distance; if he had to transport this as a single unit, he would require frequent stops for rest, and at the end of one hour might have covered 1½ miles; his output in terms of transport would be 0.06 ton miles per man per hour. If the load were halved and shared between two men each carrying 0.02 tons (45 lbs.), the intervals lost for rest would be reduced and the distance covered might be increased to 4 miles; the output in terms of transport would be 0.08 ton miles per man per hour, an increase in efficiency of 33⅓%.

This standard of transport ruled for countless years during the early days of civilisation and in undeveloped parts of the world is still in operation to-day, but as the human race developed, aids to locomotion were introduced—the sledge, the animal (usually the horse), the wheel, the boat, the mastery of steam power leading to the locomotive, the railway and the steamer, the mastery of the internal combustion engine leading to the motor lorry and the aeroplane. Still in the experimental stage and not yet adapted for transport are the utilisation of jet propulsion, which may in the not too distant future be found of great value to water transport, and later the mastery of atomic energy.

Without any attempt at introducing detail or a factor for the power value of the mechanical appliances used, the following table sets out the stages in the development of the Transport Unit:—

Mode of Transport	Weight tons	Speed Miles hour.	Men employed	Transport Unit : Ton-Miles hour
Man	0.02	3.5	1	0.07
Packhorse	0.20	4	1	0.80
Horse and Cart	2	4	1	8
River Boat (1720) ...	30	3	3	30
Broad Canal Boat (1760)...	50	3	3	50
Narrow Canal Boat (1760)	24	3	2	36
River Boat (1790)	60	3	3	60
River Boat (1830)	100	3	3	100
Mechanical Age—Steam Engine:				
River Boat (1870)	200	4	4	200
Railway	400	24	3	3.200
Mechanical Age—I.C. Engine:				
Road Lorry	5	30	1	150
	10	25	1	250
	15	20	2	150
Aeroplane	3	200	3	200
Narrow Boat	25	4	2	50
Narrow Boat and Butty ...	54	3	3	54
Broad Boat	50	4	2	100
Standard Barge, in Canal	100	4.5	2	225
" " in River	100	5	2	250
" " in Estuary	100	6	2	300
Broad Barge	200	4	2	400
Compartment Train ...	700	4	4	700

In each case the weights quoted must be taken as typical loads and the distances covered in an hour are typical figures for the periods during which the goods are in transit. Factors such as the provision and maintenance of track, whether railway lines, road or waterways are excluded; also time consumed in loading, assembling, shunting and discharging. Moreover, the transport units reached in the last column are based solely on the number of persons immediately employed in the actual movement of the goods themselves and are related thereby solely to the hourly wages of labour and are not adjusted to take account of mechanical power and of the hourly cost of providing and operating the engines or of servicing and administration of the track, the terminals, transhipment points, etc.

Subject to these qualifications, the figures do reveal the following features of value to all interested in transport and particularly in water transport:—

(1) The rapid increase in the transport unit during the eighteenth and early nineteenth centuries, following the development of inland water transport.

(2) The great increase in the transport unit during the nineteenth century, following the development of rail transport.

(3) The overpowering supremacy of rail transport for the carriage of goods traffic once the train has been assembled and so long as it continues in transit.

(4) The handicap under which water transport has to operate now in competition with its rivals of rail and road, where the carrying capacity of the individual barge is small.

(5) The steps taken to overcome this handicap by the enlargement of waterways to increase the carrying capacity of the individual barge so as to obtain higher values of the Transport Unit.

It cannot, however, be too strongly emphasised that the figures set out in the table only relate tonnage in transit to the individuals immediately engaged in the movement and that many other factors

British Canals and Inland Waterways—continued

must be taken into account before the relative efficiencies of the various forms of transport can be fully assessed.

ENLARGEMENT OF WATERWAY AND EFFECT ON TRANSPORT UNIT

Since an increase in the value of the Transport Unit is essential to meet the challenge of other forms of transport. Managers and engineers interested in water transport have to give full consideration to the question of enlargement of the waterway. A first requirement is that the principal traffics of the industries or of the area served by the waterway are of such a character as will require large consignments and will benefit from the expenditure by permitting the traders to increase the tonnage carried by using larger vessels with the same manpower. The enlargement of locks and other masonry structures may be formidable, but the problems involved are usually straightforward. The enlargement of the channel and the selection of the ideal section do, however, introduce features of considerable interest.

Some aspects of this problem have been studied in connection with the preliminary investigations into the possibility of enlarging the waterways connecting the Midlands to the ports. The present boat unit in general use consists of a powered boat carrying about 22 tons and towing a dumb boat carrying about 26 tons, giving a combined capacity of 48 tons. These travel at a speed of about 3 miles per hour and have a crew of three; the Transport Unit value is therefore 48, only about one-third of that of the road transport vehicle. The proposal to enlarge the waterways would permit powered barges to operate carrying 100 tons with a dumb barge in tow carrying 140 tons; if the waterway is enlarged to such a section as will permit speeds of 4 miles per hour to be maintained, the Transport Unit with a crew of four men between the two vessels is increased to 240, five times as high as the present Unit and fully competitive with that of the road vehicle.

WATERWAY DEPTH

Analysis of various types of channel section revealed that the optimum efficiency was obtained by providing a waterway whose cross-sectional area was five times that of the cross-sectional area of the barge and whose surface width was between four and five times the width of the barge. With channels of normal trapezoidal shape, the requisite depth below the barge amounted to at least 3-ft. Any reduction in this depth resulted in a rapid reduction in the speed of the barge or, conversely, a rapid increase in the power required to propel the barge at the same speed.

The experimental work, from which these conclusions are taken, was undertaken at the National Physical Laboratory, Teddington, in the model tank, at the request of the Ministry of War Transport. Since these experiments may be the subject of a forthcoming paper to be presented for discussion at an early date, it would be inappropriate to set out the details here, but the important feature which is stressed as a measure for accelerating water transport is that there must be adequate depth of water below the vessel in order to obtain speed and economical operation.

TOWAGE

The provision of towage facilities has received careful consideration not only in connection with the speeding up of the traffic movement, but also with regard to the cost of operation (additional crew, engines, etc.) and with regard to the provision of locks of a size sufficient to contain the towage unit and the towed vessels at a single operation.

Consideration has been given to the following, among other, combinations of tug and dumb craft:—

(a) Three, four, five or more dumb barges towed by a single powerful tug;

(b) Powered barges carrying cargo and towing one or more dumb barges;

(c) Powered barges operating as single units.

Analysing these towage types:—

(a) Dumb Barges Towed by a Single Tug.

This type of fleet has many advantages where large consignments are moved over long distances and where the train once assembled proceeds through to destination as a unit. It is in regular use on the Continent, particularly on canalised rivers. It is also a type of fleet much favoured by lightermen and operators whose activities are confined to ports where the average towage distance from loading to discharging point is short and where one or two mobile tugs can provide an efficient service for the movement of a large number of dumb barges. Within reason, there is no limitation on the number of barges that can be moved by a single power unit specially designed for towage and in itself performing no carrying function.

For general traffic on inland waterways of an entirely artificial nature where locks tend to be frequent, where the loading and discharging points are at a considerable distance from each other and where the tonnage movements are of moderate magnitude only, this type of fleet ceases to be economic. A tug allocated to two or three barges on such a route would be involved in considerable waiting periods at both the loading point and at the discharging point unless the traffic was of such a nature that there were always light or loaded barges ready at each end for movement as soon as the tug arrived with its existing train. Where barges are working to or from ports such regularity of traffic movement is almost unobtainable by reason of the fluctuations in the arrival or departure of ocean-going vessels and it would be inevitable that from time to time the tug would be required to traverse the whole distance without any corresponding movement of barges.

The " transport unit " in a fleet of this type is high once the train is assembled, but the terminal delays and periodic light operation of the tug do not lead to economical working.

On the Aire and Calder system there is a special type of craft known as a " compartment " used for the transport of coal by canal. A train of these " compartments," nineteen in number, is formed, towed by a tug with a crew of four men to the docks for shipment. Each compartment carries about 40 tons, so that the complete train has a total capacity of roughly 700 tons. They are not used on tidal waters.

(b) Powered Barges Towing Dumb Barges.

This is a type of operation much used in England, particularly on the narrow canals, where by virtue of the small carrying load the " transport unit " of the single powered boat is very low. For loading or discharging at wharves where the powered boat and the towed boat can be loaded or discharged at the same time, the terminal delays are entirely eliminated. If the points are not adjacent but are in the same area, the powered vessel has to spend some time in putting the dumb boat into position and returning to its own loading point with a similar movement on completion of loading. Similar conditions apply to larger barges, the essential feature favouring the adoption of this type of operation being that loading or discharge of the powered unit and of the towed unit should be simultaneous.

(c) Powered Barges Operating Individually.

This type of operation relies upon the mobility of the vessel. While their initial cost is higher than that of a similar sized dumb barge, and while the crew needed for manning them is greater than that of the dumb barge, they have the great advantage of eliminating or of reducing to a minimum the terminal losses. As soon as the boat is loaded or, if operating on tidal waters, as soon as the tide permits, the boat and its cargo are able to move forward towards their destination. For a bulk movement of 400 tons from a single loading point to a single discharging point at the other end of the journey by means of vessels each carrying 100 tons, the traffic flow starts immediately one quarter of the consignment has been loaded to barge, and subsequent 100 ton lots will be in transit at regular intervals as loaded. At the discharging end, provided that the discharging rate is equivalent to the loading rate, the first barge will be completing its discharge as the second boat is arriving, and similarly with the later barges, ensuring a steady and continuous movement of the traffic both at the loading point and at the discharging point.

Summing up:

The tug and dumb barges provide a combination which probably requires the least number of men and the smallest amount of engine power; it shows a high " transport unit " and can be used economically either at ports where the barges need only be provided with crews when actually in use and where the individual tug can

British Canals and Inland Waterways—continued

serve a large number of dumb barges or on inland waterways where the traffic between two points is of such a volume and of such regularity that the tug and the crews spend a minimum of time at each terminal, the tug turning round and the crews changing from loaded to empty barges (or vice versa) for the return journey.

The powered barge towing a dumb barge is of value where both the loading and the discharging points of each vessel are close together and where the traffic movements are regular.

The independent powered barge has great value when dealing with irregular traffic movements, in the conveyance of consignments from or to steamers at the ports, and in all cases where mobility and prompt delivery of goods is of major importance.

The final decision between the use of tugs or powered craft must depend on the local conditions; for the proposed development of the waterways between the main English ports and the Midlands, the committee anticipated that the traffic would probably be handled most expeditiously by powered barges generally operating individually but also, as occasion arose, towing dumb barges of similar dimensions.

LOCKS, ETC.

In England where its waterways are subject to steeper gradients than are general on the Continent, the number of locks is higher in proportion to the length of waterway, and delays arising from the passage of vessels through locks have a very material bearing on the time of the journey.

In order to minimise the delays arising from this source and to effect acceleration of transport, it is imperative that the locks on a waterway shall have such a capacity that a full train of vessels may be passed through at a single operation.

Where the traffic movements are variable and provision has to be made for single barges as well as for trains of barges, a single lock chamber of a size to accommodate the full train would be unduly wasteful both of water and of time whenever a single vessel passed through.

To eliminate this defect of a single lock, multiple locks are desirable, two separate chambers being provided side by side, the one chamber having a width to accommodate with reasonable clearance a single barge, the other chamber having a width to accommodate with reasonable clearances two barges lying abreast of each other. The further provision of a central pair of gates (or, in the vertical lift type, a central gate) in order to sub-divide each chamber gives the maximum flexibility both for the passage of traffic and for economy of water consumption.

With such a layout, single boats can be locked through by means of the upper half or the lower half of the narrow lock, two boats passing together can be locked through either by means of the whole of the narrow lock or by means of the upper half or the lower half of the broad lock, while for a train of four (one powered unit towing three dumb barges or four individual barges) passing at the same time, the whole length of the broad lock is utilised.

LOCK GATES

The arrangements for the opening of lock gates merit consideration not only from the mechanical aspect of providing a means of moving a vessel from one level to another, but also from the operational aspect of effecting the movement with a minimum of delay.

Single leaf or mitre gates opening by rotation round a vertical heel post have to displace a large volume of water during the sweep of their operation and rapid operation is impracticable. To neutralise this slow operation the lower sluices are often opened to produce a current through the lock, as a result of which the gates are drawn into heavy contact with the cills, frequently causing damage. In many recent canals this type of gate has been replaced by the vertical lift or guillotine type, which can be raised or lowered more quickly than the rotating type, since a minimum of water is displaced during the movement.

The use of the guillotine gate is, however, limited to waterways where barges are subjected to restrictions on their headroom. Overhead gantries have to be provided for the operation of the gates and in lock chambers with central gates, operating alternatively as upper or as lower gates, according to which portion of the lock is in use, the central gate requires a vertical travel longer than the top or the bottom gates.

As a measure for accelerating transport on a waterway, there are many points in favour of a more general use of the guillotine gate; the provision of rollers of a form similar to the vertical lift Stoney Sluice gate would merit consideration so as to permit the gate to be partially raised prior to the equalisation of the water levels. The gate would thus act in combination with compensatory wall sluices both as a quick-opening gate and as an effective addition to the filling and emptying capacity of the lock.

LIFTS

The use of the vertical lift, which provides a large step up or down in a single operation in place of a series of locks, has many features to commend its use at suitable sites as a measure for accelerating transport. On a canalised river, where gradients are necessarily gentler, or on artificial canals traversing moderately level country, it would be unmerited and uneconomic to use it instead of a lock; but in an artificial canal traversing hilly country, a suitable trace could be selected with a new canal to provide the maximum length of level pounds with a minimum number of stoppages to move a vessel from one pound to another. An instance of such an artificial canal where lifts have been used in preference to locks as a measure for accelerating the movement of traffic is the Belgian canal between Mons and La Louvière. On this length, three lifts are utilised to overcome a rise of about 200 feet; if locks had been used, 20 or 25 would have been required. Since the time of operation of a lock and of a lift is similar, the time saved is proportional to the difference between the number of lifts and the number of locks, and, in this case, the acceleration of transport obtained from the use of lifts is very valuable.

In an existing canal the replacement of a group or series of locks by a lift can be used in suitable instances as a measure of accelerating transport. With a 50-ft. rise to be overcome, one lift could be used in place of six locks with a rise of 8-ft. 4-in.; the saving of time by the use of a lift would amount to 83.3%. An example of such a substitution is found in Northern France, where the lift at Les Montinettes, near St. Omer, was constructed to replace five locks.

A similar utilisation of this method of accelerating transport has been introduced into the proposal for modernising the waterway between the River Mersey and the Midlands in England, to which reference has already been made. In this instance, where consideration is being given to the enlargement of the waterway to allow 100-ton barges to be used instead of the present 25-ton boats, the existing locks were grouped into a series of five locks at Market Drayton, of five locks at Adderley, and of 15 locks at Audlem, where the canal below the locks spans the valley of the River Weaver 44 feet below. In the proposed scheme, the five locks at Market Drayton would be replaced by one lift, and the other 20 locks and the difference of level between the canal and the river would be overcome by a further three lifts. Three lifts would raise barges from the rivel level to the upper pound through a vertical height of 168-ft. in three operations, whereas 27 locks, each with a rise of 6-ft. 3-in. (the general average for this canal), would be needed if the existing locks were enlarged and if similar locks were used for effecting the new connection between the canal and the river. Allowing an average of 15 minutes for the overall loss in time in passing through a lock or lift (including therein the time lost in decelerating for the lock, the actual time of operation and the time lost during acceleration to normal speed, and excluding time lost for running off a lock if not ready for use), the time lost in overcoming the 168-ft. rise by three lifts would amount to 45 minutes, and by 27 locks it would amount to 405 minutes. The saving in time by the use of lifts would amount to 360 minutes (6 hours) for every barge using the waterway, a very material measure for accelerating transport.

LIGHTING

This is a feature to which specific reference has been made in the questionnaire; consideration has been given to its use in relation to the illumination of the waterway and to its use in relation to the illumination of locks.

With regard to the illumination of the waterway, it is very doubtful whether side or overhead lighting such as is used on roads in towns or built up areas could ever be generally adopted or could

British Canals and Inland Waterways—continued

be desirable as a means of accelerating transport. The conditions on a waterway are so different from those on roads, where vehicles move at relatively high speeds on unfenced roads on to which animals, pedestrians, and particularly children, may walk without prior warning; even with these risks to the safety and life of the road user, side or overhead street lighting is only adopted in towns or at junctions where the concentration of traffic or the incidental risks are high; elsewhere on the road, the vehicle relies for the illumination of the roadway on lights transported with and operated from the vehicle itself.

Water transport, with its larger individual loads, fewer individual units, slower speeds and no risk of trespass on the waterway itself, does not need permanent illumination of the channel. Motor boats, like motor vehicles, can generate sufficient power to operate their own lighting for the illumination of the waterway ahead.

While general illumination of waterway channels is not advocated as a means of accelerating transport, some assistance may be given to the crew of boats navigating after dark by providing fixed lights or glass stud reflectors now in general use on the roads at bridge openings, lock entrances and other narrow places on the waterway.

With regard to locks, these have many features which make them difficult to operate in the dark; the side walls are unfenced and somewhat dangerous; the sluice and gate operating handles are difficult to locate. Boatmen called upon to operate the locks for the passage of their vessels are in consequence reluctant to travel after dark. This reluctance can to some extent be overcome by the provision of overhead illumination at locks, and by this means a considerable acceleration of transport can be effected, particularly where relief crews can be arranged so that the traffic moves steadily day and night to its destination. Objections to the illumination of locks are that it is uneconomical to have lights burning all the night for the sake of intermittent vessels, that if switches are provided for them to be illuminated by the bargemen on arrival they are not turned off, that the switches will be operated by unauthorised persons, and that the brightness of the lights and of the illuminated area at the lock tend to dazzle the steerer and to make by contrast the lock chamber itself and the approaches thereto more difficult to locate. These objections can be met in a practical way by providing a master switch at each lock operated by a special key issued to bargemen and controlled by a time switch, set to extinguish the lights in stages after a period sufficient to enable the lockage operations to be completed. With this provision, the steerer can take his boat into the lock approaches and lock chamber assisted by stud reflectors; when in the lock, one man can go ashore with the master key, illuminate the lockside, operate the sluices and gates in safety, and take his boat out on its journey, leaving the lights to be automatically extinguished after a short interval. Moreover, the use of sodium lighting eliminates the glare and has proved very effective in this country and on the Continent.

BRIDGE OPENINGS

In many of the older canals in England, locks, aqueducts, bridge openings, tunnels, and, in general, any masonry structure was constructed with a minimum of clearance to enable a single vessel to navigate. Bridge openings of this nature not only prevent boats navigating towards each other from passing, but also provide checks to the navigation of all boats, and particularly in the navigation of self-propelled vessels. When such vessels approach a bridge opening of this restricted type, there is a definite reduction in the speed, almost automatic on the part of the steerer, who is concerned with getting the bows of his vessel through the narrow opening without bumping the side walls, with possibility of damage to his boat or cargo. The time lost in decelerating for such a bridge, in passing slowly through the opening, and in accelerating to normal speed can well amount to 1½ minutes; with an incidence of four bridges in a mile, an hour would be lost in 10 miles. A boat running steadily at 4 miles per hour would cover this distance without checks in 2½ hours: with these checks the time is increased to 3½ hours, a delay of about 40% in the time of navigation.

Apart from the retardation deliberately imposed by the steerer to enable him to navigate his vessel through such a restriction, the physical reduction in waterway area and the consequent inability for the water to flow freely past the vessel will cause an automatic check on the speed.

For the sake of accelerating transport on the waterway, it is very desirable that obstructions to the free movement of traffic such as these bridgeholes, etc., should be eliminated and that a waterway of uniform width and depth should be provided throughout, with no restrictions introduced by the passage of roads or railways over the navigable channel.

TUNNELS

These structures are almost invariably suitable for single way operation only; to double the width of the waterway, it would be necessary to quadruple the cross-sectional area of the tunnel. With tunnelling costs increasing at a higher ratio than the direct increase in cross-sectional area, the reasons for the curtailment of tunnel section to a minimum are obvious.

In a few cases where the depth of soil over the arch of the tunnel is not excessive, modern technical handling equipment might be utilised to convert a tunnel into a cutting. Where such conditions do exist, this solution merits consideration as a measure to accelerate transport.

In the majority of cases, however, such a solution will not be practicable and the presence of a tunnel must be recognised as an unavoidable impediment to the uncontrolled movement of traffic. The only measures that can be taken to accelerate transport are such as will ensure a minimum of delay. Where boats work themselves through a tunnel, the speed of the vessel will undoubtedly be reduced, firstly to ensure satisfactory steering without contact with the sides, and secondly by reason of the restricted waterway, which checks the free passage of the water past the sides of the vessel. Such reductions in speed are unavoidable and, while in a long tunnel they may appreciably delay the journey time, greater delays are probably caused by the necessity of working traffic through the tunnel in alternate directions. Such restrictions often take the form of pre-determined periods during which vessels may pass into the tunnel at one end, followed by periods during which vessels may not enter from either end before the cycle is completed. Apart from its simplicity and from the fact that the periods available for entry are known to bargemen, who can to some extent arrange their arrival to conform with the periods, there is little to commend this method, as it allows for no flexibility to suit the movement of traffic. If a boat arrives just after the period of entry, it will have to wait through three periods (two dead periods and one reverse direction period) before it can enter, even though there may be no boat at the other end awaiting passage.

Personal control by special staff at each end connected by telephone will reduce the delays by allowing traffic to enter according to its needs, but the operating costs of such control are very high if special staff has to be employed. If the tunnel is situated within reasonable distance of a lock at each end, the locktenders connected by telephone can exercise proper control over traffic movements by keeping the vessels at the locks instead of allowing them to proceed unduly early to the tunnel mouth.

An alternative worth consideration in some cases is an adaptation of the automatic road-traffic lights, whereby red and green are provided at each end of the tunnel with facilities for a boatman to record his arrival at one end and to obtain permission to enter by the green light illuminating if no call has been recorded at the other end within the periods necessary for the passage of a boat.

In tunnels where towage is provided as a compulsory feature for the passage of traffic, time-table operation is inevitable.

The foregoing notes touch on a few aspects of canal operation and maintenance and indicate certain measures for accelerating transport. In many other ways, the canal maintenance engineer can work to the same end. The removal of shoals, the setting back of a corner, the elimination or smoothing out of bends, local widening, cutting back of an overhanging tree, improvement of sight line by cutting down bushes, electrification of bridge or lock mechanism, these and many other details, small in themselves, have a cumulative effect on the acceleration of transport, and it falls on the canal engineer in charge of any waterway to make himself acquainted by regular trips on the traffic boats with the checks and difficulties experienced by the steerers, to take steps to eliminate the defects and to remember at all times that good maintenance should always be directed towards measures which will lead to the acceleration of transport.

Quay Reconstruction at Wallsend

Ingenious Adaptation and Piling Methods

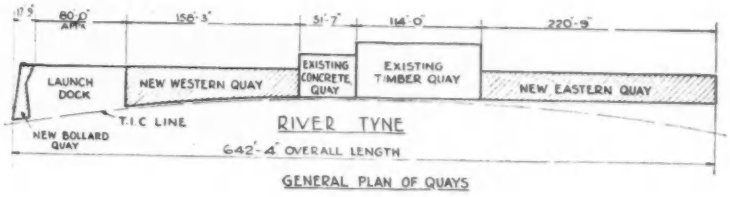
(Specially contributed)

AT Wallsend-on-Tyne, the Quay at the Turbinia Works, belonging to the Parsons Marine Steam Turbine Co., Ltd., was reconstructed recently. The new structures comprise the eastern and western extensions (Figs. 1, 2 and 3), and the bollard quay (Fig. 4), 220-ft. 9-in., 158-ft. 3-in. and 17-ft. 9-in. long respectively. The extensions are similar in design and comprise two rows of reinforced concrete piles 16-in. x 16-in. square, 60-ft. long at 18-ft. centres with an additional row in the western section, to support the front of the deck projecting to the curved river line, stipulated by the Tyne Improvement Commissioners.

Construction below high water was generally in precast reinforced concrete and elsewhere it was, of course, cast in situ. At a level sufficiently high above low water to enable construction to proceed at most states of low tide there were horizontal reinforced concrete braces running transversely and longitudinally, and diagonal braces extended from this level to the ends of the rear row of reinforced concrete piles.

The piles carry a deck with the necessary beams, designed for a superimposed load of 672 lbs. per square foot, a 30-ton portal crane on four-wheeled bogies imposing a maximum wheel load of 45 tons, a 90-ton turbine on an eight-wheeled truck drawn by a 48-ton locomotive, together with the loads sustained by berthing and mooring bollards.

The deck beam system comprises large front and rear longitudinal main beams which carry the crane rails, two smaller longitudinals for standard gauge rail track together with transverse beams (Fig. 5).



GENERAL PLAN OF QUAYS

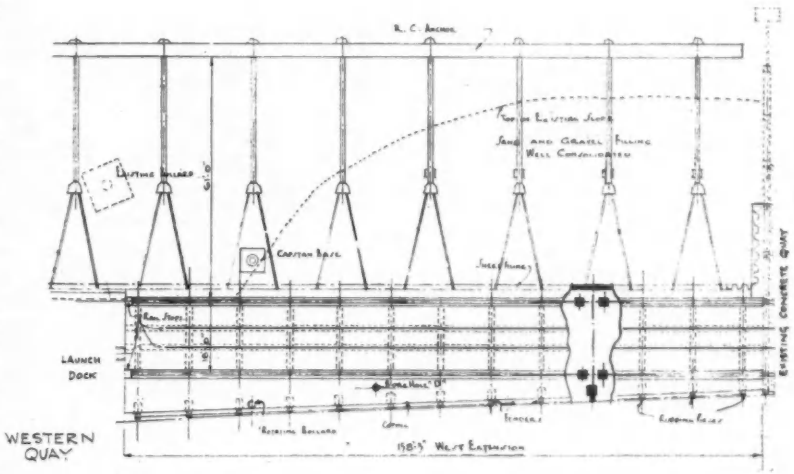
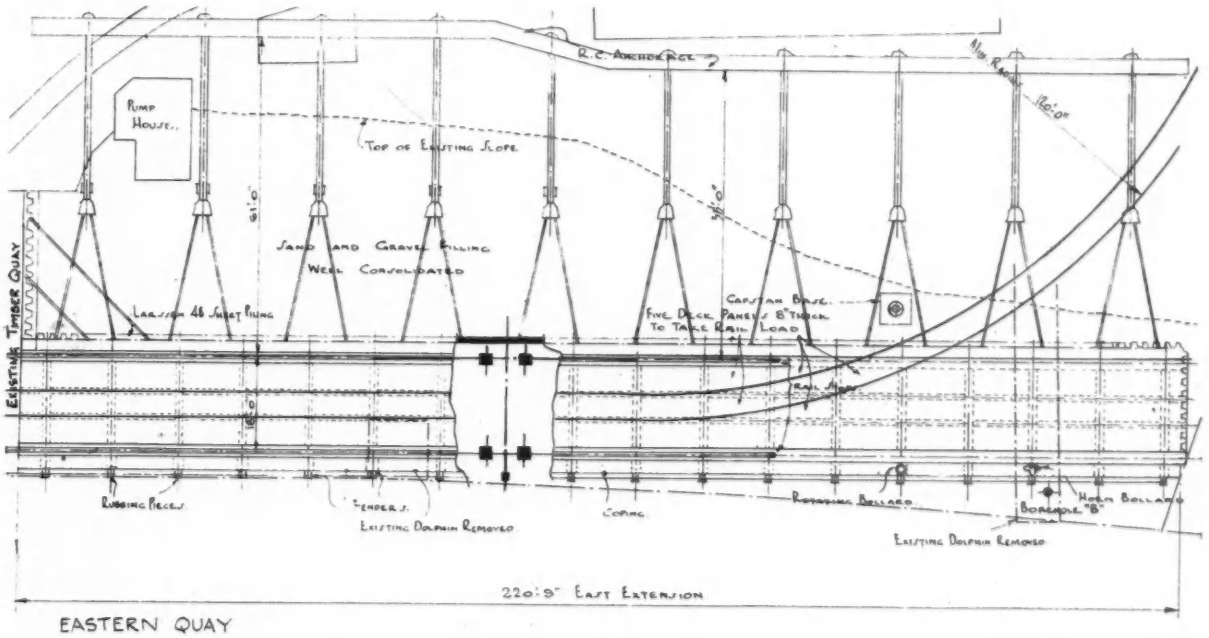


Fig. 1 (above). General Plan of Quays and of Western Quay.

Fig. 2 (below). Plan of Eastern Quay.



Quay Reconstruction at Wallsend—continued

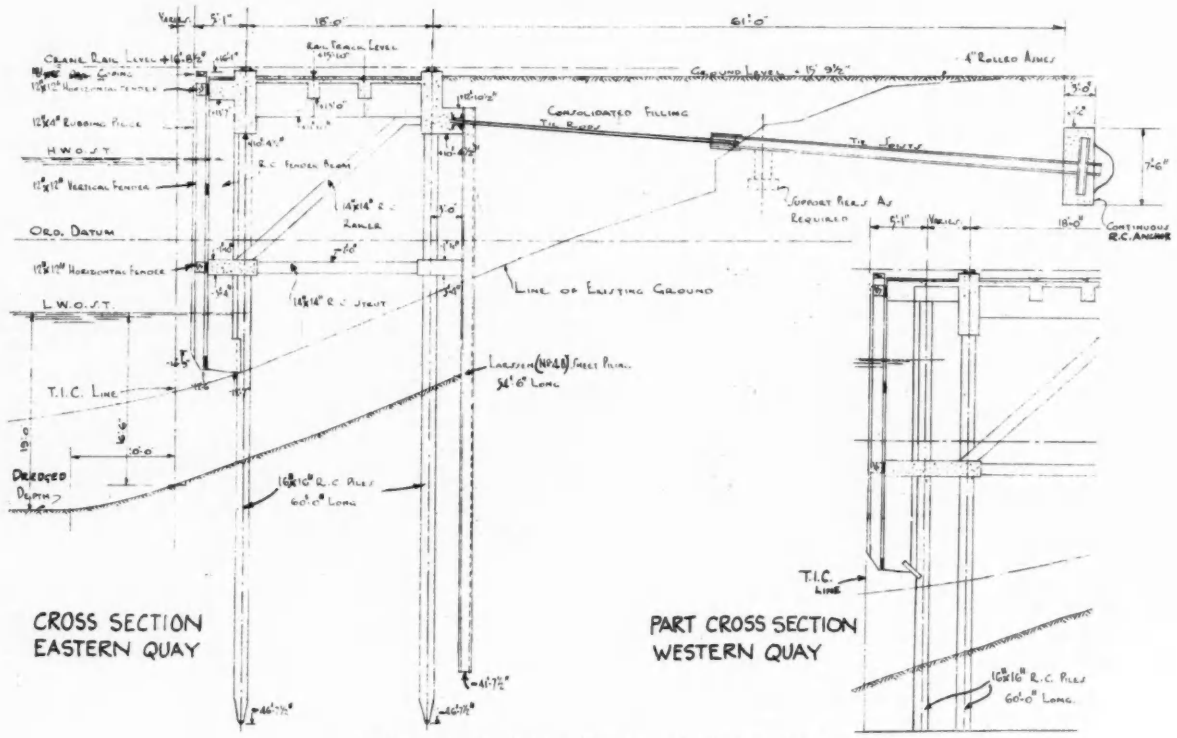


Fig. 3. Cross-Sections of Eastern and Western Quays.

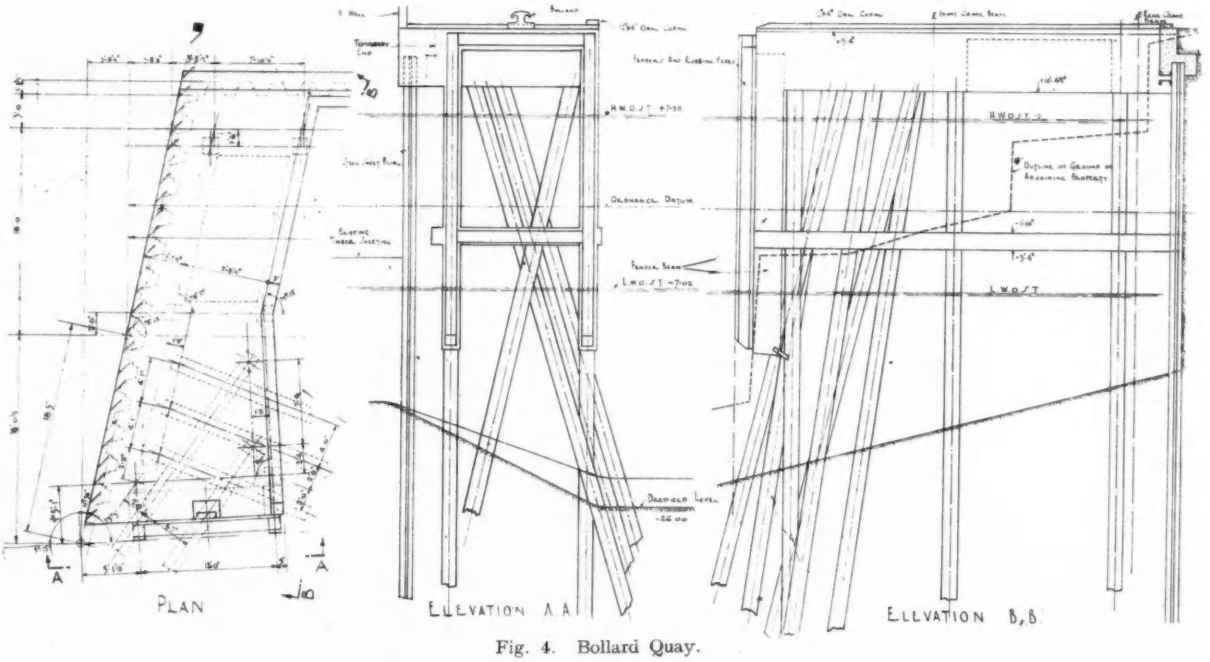


Fig. 4. Bollard Quay.

The piles bear on a strata of gravels and sands above which are silts and sands; soft ground occurs in places below the gravel. The driving generally gave a set of ten blows for a penetration of 1½-in., but the severity varied from 2-in. for ten blows to refusal. Driving was carried out by a 3½-ton semi-automatic steam hammer with a fall of 3-ft. 6-in., and the greatest working load on one pile is 54 tons. The depth of water alongside the quays is about 34-ft. at H.W.O.S.T.

The ground and filling behind the wharf are retained by a wall of steel sheet piles tied at the head by twin steel tie rods connecting a steel I beam and a continuous reinforced concrete anchor wall 7-ft. 6-in. deep and 3-ft. thick (Fig. 6). The outward deflection of the sheet piles imposes an outward thrust on the transverse horizontal braces which is resisted by a tension in the diagonal tie, which, in turn, is resisted by the rear longitudinal beam of the deck in which the tie rods are anchored.

The mixture of the concrete used was 1 : 2 : 4 in work above water and 1 : 1½ : 3 in piles and other precast members below water. The design stresses were generally 18,000 lbs. per sq. inch in mild steel reinforcement and 750 lbs. per sq. inch in con-

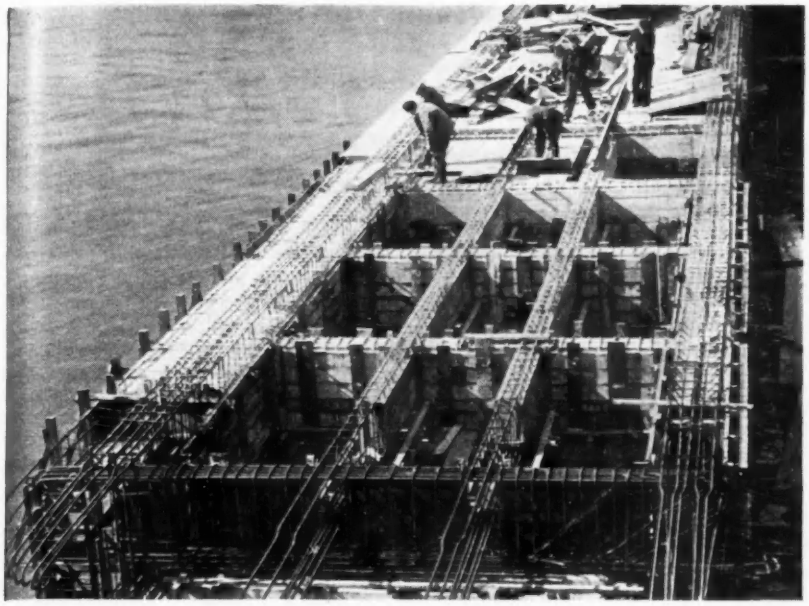


Fig. 5. Construction of Deck.

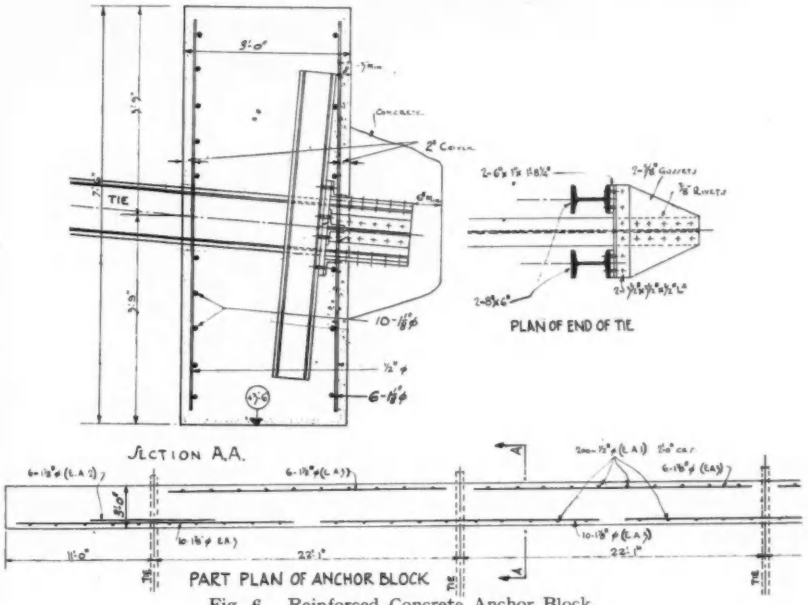


Fig. 6. Reinforced Concrete Anchor Block.

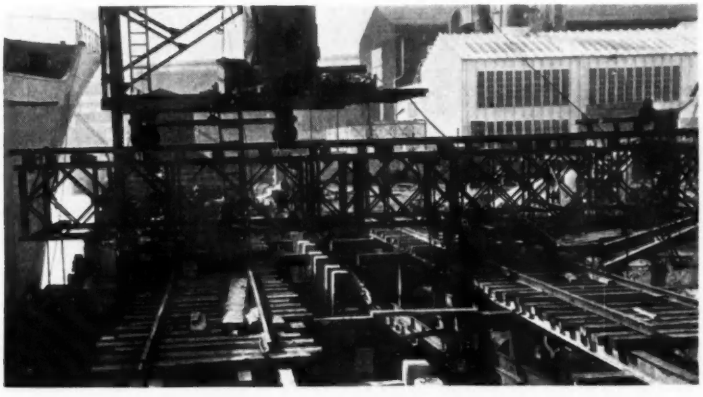


Fig. 7. Pile-driver on Cantilevered Undercarriage.

Quay Reconstruction at Wallsend

—continued

crete, the modular ratio being 15. The coarse aggregate for the concrete was crushed whinstone, and natural sand and rapid-hardening Portland cement were used. The whinstone often contained a considerable amount of dust. Batching was by volume and the specified minimum strength of 6 inch cubes was 4,500 lbs. per sq. inch in fourteen days. This strength was easily exceeded, and some cubes tested at seven days broke at over 6,000 lbs. per sq. inch.

The bollard-quay Fig. (4), is a small separate structure at the extreme western (upstream) end of the quay and was designed for a mooring pull in any direction. The structure is supported on six vertical piles and five piles driven to a rake of 1 in 3. The vertical upward component of the force of the bollard is resisted by the weight of the structure and the frictional resistance of the reinforced concrete piles and steel sheet piles.

The fendering of the main frontage consists of 12-in. x 12-in. timbers running horizontally and vertically with 12-in. x 4-in. vertical rubbing pieces and 12-in. x 6-in. oak coping. A precast reinforced concrete vertical fender-beam is suspended from the front main beam and built into the lower horizontal reinforced concrete longitudinal brace. Guards are provided at the bottom of the fenders to prevent ropes being caught behind the fenders.

The method of construction was largely dictated by the shortage, at the time, in the supply of steel sheet piling. It was necessary to devise a scheme whereby the reinforced concrete piles could be driven in advance of the steel sheet piling and, therefore, at a maximum distance of about 70-ft. from the existing river bank. The Contractors elected to do this by the ingenious adaption of Bailey Bridge Equipment to form a mobile cantilever piling carriage (Fig. 7). This was done as follows:

Firstly a timber gantry was constructed between the bank and the line of the new quay upon temporary timber piles driven by means of false leaders and a 30-cwt. drop hammer. This was made parallel to the line of the piles to be driven and to a rail track laid on the bank. Another rail track was laid on the gantry. These two rail tracks carried a travelling 10-ton derrick and also bogies carrying a modified double-single Bailey bridge section frame, running at right angles to the tracks and cantilevering out 40-ft. over the river. Rails were laid along the top chords of the Bailey trusses and carried a standard 50-ft. steel pile frame with a No. 20 Spencer Hopwood Boiler. Thus the pile frame could be run out over the river and the whole Bailey carriage could be moved laterally along the job. It had been anticipated that, when driving the outer row of precast piles, it would be necessary to pack the Bailey frame from the inner row already driven in order to minimise whip and sway, but in practice this was found to be unnecessary and the pile frame was cantilevered out the full distance from the outer rail.

At the west end, the line of the quay was considerably farther from the bank than at the east end and, therefore, it was not practicable to carry the tail of the Bailey trusses on a track on shore. In order to deal with this condition two timber gantries were constructed, one between the precast piles and the shore, and the other between the two main rows of precast piles. This form of

Quay Reconstruction at Wallsend—continued

construction reduced the cantilever distance of the Bailey frame very considerably.

An additional hazard, which had not been envisaged at the commencement of the job, was the fact that the newly-launched hulls of ships of up to 10,000 tons, while they were being fitted

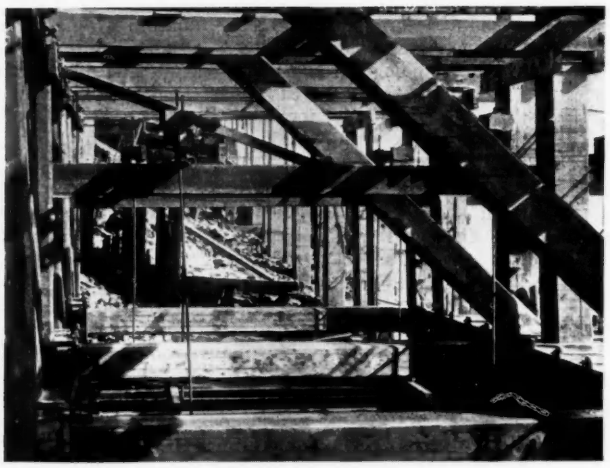


Fig. 8. Suspended Shuttering.

out, were moored to the very short existing quay in the centre of the new work. During periods of high winds these caused considerable anxiety as they swung very close to the end of the cantilever frame, whilst the heavy mooring wires running across the work rose and fell, with a dangerous and sometimes damaging effect upon the temporary timbering and travelling derrick.

In spite of some very hard driving with long unsupported lengths of piles from the bottom of the leaders to hard ground, and the fact that the bank sloped out steeply into the river, the piles were driven very accurately to line and plumb.

Some difficulty was experienced in casting the lower braces at the front of the quays. The bottom of these beams are about 2-ft. 6-in. above extreme low water and were, therefore, too close to the water for sufficient frictional support to be provided by clamping to the piles for shuttering support, as these piles became covered with oil from the river. The shuttering for these beams

Fig. 9. Pile Casting Beds.

was, therefore, suspended by long tie rods from steel channels bolted to the piles at their upper lifting holes (Fig. 8).

The Consulting Engineers for this work were Messrs. R. T. James and Partners, and the Contractors, Messrs. Geo. Wimpey and Co. Ltd. The original contract price was about £100,000.

Book Reviews

TWO CENTURY BOOKS

Of the large number of Festival of Britain books being issued, two of the first look like being two of the oustanding, and one of them at least has a very direct appeal to readers of "*The Dock and Harbour Authority.*" This is **A Century of Technology**, edited by Percy Dunsheath, C.B.E., D.Sc., M.A. and published by Hutchinson's Scientific and Technical Publications at 15s.

This survey of the technological achievements of the past century is divided into 19 chapters covering raw materials, engineering transport and communication, all interpreted in the widest possible sense. Each chapter is written by an expert on the subject, thus the chapter on Iron and Steel is contributed by no less an authority than Sir Charles Goodeve, F.R.S., Director of the British Iron and Steel Research Association and indeed, directors of appropriate research associations figure prominently throughout the book, as for instance in the chapter on Non-Ferrous Metals by G. L. Bailey, M.Sc. (of the Non-Ferrous Metals Research Association), Fuel and Power by Dr. D. T. A. Townend (Director of the British Coal Utilisation Research Association), Production Engineering by Dr. D. F. Galloway (Director of Research of the Production Engineering Research Association), and Sir James Turner, B.Sc. (of the National Farmers' Union).

Of the subjects likely to appeal directly to our readers may be mentioned Fuel and Power (already cited), Prime Movers by H. Bedford, B.Sc., Petroleum Technology by Dr. A. E. Dunstan, Transport by W. H. Johnson, M.A., A.I.N.A., Navigation by F. George, M.A., and Telecommunications by Lt.-Colonel Chetwode Crawley, O.B.E.

Each author has taken 1851 as his approximate starting point, though this does not mean that earlier developments when important have been entirely ignored, and he has traced the development of his subject up to the present day. Very significant it is that although credit is given all over the world where it is due, Britain seems to have lead the way in more fields than is generally realised. The standard of writing is such as to appeal to intelligent and responsible readers and a surprising amount of detailed information has been included in some of the chapters, which is amplified by tables and diagrams where necessary. There are also 20 pp. of half-tone illustrations.

The companion volume of **A Century of Science** edited by Herbert Dingle, D.Sc., and published at the same price of 15s. nett, probably has less appeal to seagoers and dock users as such, for, as may be expected, it deals more with the fundamentals of a subject than with the practical applications. As in the first book, contributors include the leading authorities in their respective spheres and the subjects range from the fundamentals of energy and physics to astronomy, evolution, anthropology, pychology and medicine.

Both books may be commended without qualification to engineers, seamen and scientists wanting to widen the scope of their knowledge or to increase their information about the historical development of the matters with which they are dealing everyday.

Construction of Inland Waterways (Der Wasserbau an den Binnenwasserstrassen) by Mylius and Isphording, re-edited by Walther Paxman, 134 pp., 25 illustrations, price 16.50 marks. This is a revised revision of the original work and is volume I of the series. It deals with the preliminaries of construction of Inland Waterways, site investigation, foundations, plant for construction, etc. to elementary standards.

Applied Hydromechanics (Angewandte Hydromechanik im Wasserbau) by Professor Winkel, third edition, 140 pp., 90 illustrations, price 11.60 marks. A useful small volume for those interested in the more detailed mathematical analysis of mass water movement.

Maintenance and Repair of Flood Dykes (Bau, Unterhaltung und Verteidigung der Flussdeiche) third edition, by Ehlers and Winkel, 72 pp., 54 illustrations, price 5 marks. A handy little volume of use to junior engineers connected with catchment areas.

These three paper-backed volumes are all published by Wilhelm Ernst and Son, Berlin.